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GAY-LUSSAC AND BIOT MAKING THEIR BALLOON ASCENSION FOR SCIENTIFIC OBSERVATIONS IN 1804.

EDITOR'S OUTLOOK

The Frontispiece

THE quaint old cut reproduced on the opposite page is taken from the *Beginners' Hand-Book of Chemistry* by John Howard Appleton, published in 1888 by the Chautauqua Press of New York. It is supposed to depict Gay-Lussac and Biot making their famous balloon ascension for the purpose of examining the properties of the atmosphere at higher altitudes.

A rather amusing anecdote in connection with this ascension is related by Arago in his *Eloge de Gay-Lussac*. Having reached a height of about seven thousand meters and desiring to rise yet higher, the investigators set about lightening their craft by throwing out all articles with which they could dispense. Among these was a chair which chanced to alight upon an arbor near a young girl who was guarding sheep. Since the balloon was invisible to her and aerial navigation was in those days scarcely a commonplace undertaking, what could she think of the chair, save that it had been provided by a benevolent Providence? This view she maintained in the face of neighborly skepticism until the papers, in publishing all the particulars of the experiment, explained the supposed miracle.

We are so frequently confronted with the contrasts between present-day and older instruments and technique that the element of wonder has largely departed from such comparisons. In viewing this old cut, however, we cannot but recall Dr. Millikan's description of the sounding balloons employed in the investigation of cosmic high-frequency rays in 1922. We quote from his address before the recent meeting of the National Academy of Sciences: "These instruments were interesting in that, though they were built to hold 300 cc. of air at 150 pounds' pressure, and were provided each with a recording barometer, thermometer, and electroscope, also with three different sets of moving photographic films and the necessary driving mechanism, the total weight of the whole instrument was yet but 180 grams, or about 7 ounces."

Chemical Warfare

THE close of the war period brought with it the problem of salvaging or destroying considerable war-time material which was but ill-adapted to the uses of peace. Not the least of the incompleted reconstruction jobs is the correction of a great deal of war-time misinformation generally designated as propaganda. Lieut.-Colonel Gilchrist demolishes a number of popular misconceptions in his article on "The Humanity of Chemical Warfare" in *The Military Surgeon* for November, 1925.

From army records and various other authoritative sources he gathers data to show conclusively that, judged by the amount of suffering produced by the weapon, the after effects of wounds caused by it, and the percentage of deaths and permanently injured compared with the total number of wounded, gas is the most humane of all the recognized weapons of war. It will be a surprise to most readers to learn that, according to the Surgeon General's report for 1920, the annual occurrence of tuberculosis among gas casualties was somewhat lower than the general annual rate of occurrence among the enlisted men serving in Europe.

We mention Colonel Gilchrist's report here, not only because we believe that chemists and teachers of chemistry should be correctly informed concerning chemical warfare, but because it constitutes an excellent example of the application of scientific methods of analysis and investigation to the examination of a controversial question. For this reason we strongly recommend that it be read in full.

A Worth-while Project

A NEWS note in our Local Activities pages* describes a project which we believe to be worthy of further comment. We refer to the advanced course of lectures in chemistry arranged by a number of Boston high-school teachers and now being presented through the coöperation of the Massachusetts Institute of Technology.

Here we see a group of teachers not only desirous of growth but possessed of the initiative to conceive and the energy to set about creating opportunities which did not exist. Nor should we pass on without a word of commendation for the spirit of coöperation on the part of the Institute and its staff which has made the execution of the plan possible.

Chemistry teachers in many other cities could undoubtedly bring about the arrangement of similar courses. Most universities would be glad to extend any possible aid. However, we recommend as worthy of emulation, not so much the method employed, as the spirit displayed.

Tulsa Meeting

PLANS for the divisional program to be held as a part of the spring meeting of the A. C. S. at Tulsa, April 5–9, are rounding into shape. History will again combine with Education—a plan which proved very satisfactory at the Los Angeles meeting.

A number of interesting excursions to the oil and gas fields, refineries, glass and cement plants, and the lead and zinc districts are being arranged. There are also deposits of salt,

* See page 236.

gypsum, and coal which may be visited. Splendid roads pass through all these sections and many cars are offered to furnish free transportation.

Prospective authors of papers are urged to submit subjects and abstracts to Secretary B. S. Hopkins, University of Illinois, as promptly as possible. Delay in this matter occasions delay in the printing of programs and in the publication of the Society's News Edition and causes endless unnecessary trouble for those in charge of arrangements.

Educational Standards

WE BELIEVE that the time is ripe, for a more serious and concerted attack upon the problems of chemical education from an administrative angle. Naturally such an effort involves the formulation of educational standards. In asserting the necessity for standards we do not imply the desirability of molds designed to turn out uniform products. We do contend, however, that little can be accomplished without some definite end in view and some means of measuring progress toward that end.

If any shall ask for more specific indications of the need for standards, let them consider the question of qualifications for teachers of chemistry. In many small high schools, and in some large ones as well, chemistry is presented by teachers who must confess to very insufficient grounding in that subject. In many colleges, chemistry, particularly freshman chemistry, is taught by instructors who have never exposed themselves to so much as a single lecture course in pedagogy. Obviously no degree of perfection in method can be reasonably expected to compensate a deficiency of knowledge in actual subject-matter, nor can a thorough command of subject-matter be very effective without some attention to means of presentation.

For the small high school where the attendance does not permit the establishment of a separate department of chemistry, there is a possible solution in the grouping of three- or four-year science courses under one instructor. Such instructors could be trained in our colleges through the establishment of curricula which would combine a thorough grounding in the sciences with training in educational methods. In most institutions this could be accomplished by grouping already existing courses.

The college instructor is generally more reluctant to admit his deficiencies than is the high-school man. There seems to be a general sentiment to the effect that, whereas high-school students need to be **taught,** college students should be capable of **learning,** largely on their own initiative. Just what sovereign alchemy may be presumed to transform the student from a passive to an active organism in the few weeks which intervene between the June of his high-school commencement

and the September of his college matriculation, no one attempts to specify. While this view is excellent propaganda for the freshman, himself, in that it may incite him to greater effort on his own behalf, it is very dangerous reasoning for the instructor if he takes it to mean that poorer teaching methods will suffice.

Here, then, is a definite suggestion. Standard-makers could well begin by formulating standards of qualification for high-school science teachers and for college instructors in freshman chemistry.

The statement of minimum standards of achievement in chemistry courses, notably high-school and freshman courses, is another task which awaits the standard-maker. This task involves a critical consideration of objectives, a rational selection of material which can be employed to attain the objectives agreed upon, and reliable means of measuring attainment.

There has been much discussion concerning objectives—a great deal of it based on faulty reasoning and deficient knowledge of the newer findings in educational psychology. We should realize that if one grants chemistry to be a necessary factor in general education, it does not necessarily follow that chemistry must or can be made to contribute to all the objectives of general education. Particularly should disciplinary aims be examined with a critical eye. Furthermore, objectives should be stated in specific terms. Oratorical generalities, while sometimes "inspiring," are seldom practically helpful. For instance, when it is stated that chemistry instruction should aim at the training of better citizens, what, actually, is meant? Does this mean that people will be better educated for having studied chemistry, and will be better citizens for being better educated? If that is all, why mention an incident as an objective in itself? If it is not all, what then?

The selection of material to be presented is, of course, inseparably inter-related with the question of objectives. Neither can be considered aside from the other. The need for the measuring of achievement is obvious. Of what use is a goal and schedule for its attainment without some means of evaluating progress?

Imposing as all these projects may appear and as, in reality, they are, there now exists the necessary machinery to make an attack upon them. In the Senate of Chemical Education we have a body of sufficient numbers and of sufficient diversity of interests and experience to insure that no item of consequence shall be overlooked in the gathering of preliminary suggestions. The Committee of Chemical Education, smaller and less unwieldy, could well undertake the examination of this mass of material and its correlation into a definite working program, which could again be submitted to the Senate for criticism and amendment.

AN ALCHEMIST MANUSCRIPT BOOK FROM THE LIBRARY OF JOSEPH PRIESTLEY*

LE ROY S. WEATHERBY, UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES, CALIF.

This rare manuscript, nearly 200 years old, was among the relics of the home of the great English chemist, Joseph Priestley, in Northumberland, Pennsylvania, where Priestley spent his last days after his flight from England. It was preserved and handed on along with the original deed to the Priestley home through Major-General Jonathan Potts, Surgeon-General of the Continental Army, and was presented to the Chemistry Library of the University of Southern California by Professor Walter Sylvester Hertzog of the Department of History of the Hollywood High School, through Mr. Robert Odell, member of the Los Angeles School Board, a graduate of the University.

There is no question as to the genuineness of the manuscript. It is on paper slightly discolored by age but in an excellent state of preservation. It is hand written with an ink now slightly browned, but with no loss of clearness or legibility. The handwriting is of the painstaking style, akin to engrossing; a marvel of beauty and accuracy. The leaves show the pin marks by which the writing was aligned, which is characteristic of old manuscripts.

The manuscript was brought to America by Priestley, no doubt as one of his most prized possessions. That the manuscript was not written by Priestley himself is established by comparisons of photographic copies of specimen pages with Priestley's handwriting.[1] Priestley was born in 1733; and though some experimental work recorded in the manuscript is dated 1751 and 1752 at which time Priestley was 18 and 19 years of age, this was a period in his life in which he was preparing for the ministry and his scientific career did not begin until some years later. Another section, moreover, entitled "Chymical Collections from Several of the Best Modern Authors Commencing Anno 1736 to 1753," would date back to within three years of Priestley's birth. The manuscript may have been handed on to Priestley from a chemical tutor, or have been otherwise collected and prized by him, and may be one from which he obtained much of his chemical inspiration.

This manuscript is in book form, or rather is made up of three separate note-books in a single heavy paper cover. The leaves are $6^1/_2 \times 8^1/_2$ inches in dimension and comprise a total of ninety-seven pages.

The first section is entitled "Remarks on Several Curious Menstrums and on Compound Neutral Salts by Eminent Authors." This bears a

* Presented before the History of Chemistry Section of the American Chemical Society at Los Angeles, August 6, 1925.

[1] These comparisons were kindly made by Dr. Edgar F. Smith of the University of Pennsylvania.

date of 1742, but this date has been traced by a later hand with a heavy ink over what appears rather to be 1752. There are 28 pages in this section, mostly chemical recipes. It contains many references to the writings of Boerhaave, Stahl, Becher, Helmont, and others. Though the writer usually uses the written words for the elements, as gold, silver, copper, the quotations carry the old alchemist symbols and these symbols not infrequently enter into the author's discussions. In fact a single line may contain both the written word and again the alchemist symbol.

There follow next twelve pages of quotations from alchemistic writings; mostly on gold and transmutation of the metals. Quotations are mainly from Boerhaave and Stahl, with references to Helmont, Dr. Peter Shan, Claveus, Hertog, and excerpts from the Marrow of Alchemy. In quoting Stahl we have the following:

> The metals according to this author That most plentifully contains this golden ☿ (sulphur) or Fire are Iron and Copper and quotes this Adept verse of Meeter in most Languages,
>
> Latin, *"Qui non Laborat in Venere et Marte est Stultus in Arte."*
>
> English, "Who can't get Sulphur from Venus and Mart[2]
> He without doubt is a fool in our art."

Quoting further from Stahl we have:

> To prosecute the method in the Marrow of Alchemy of Calcining the Common Gold Philosophically thereby Introducing a larger quantity of this fire into its Body before the Animated ☿ (mercury) is poured on it which he adjures us not only facilitates but also shortens the operation.

This is followed by a limerick by G. Starkey.

> And if Empyricks can this art attain
> Which Greatly Puzles every chemist Brain
> Let Parents henceforth never be such fools
> As Train their children at the Chemie Schools.

On the last pages of this first folio turned over and written from the back is a copy of a letter dated London, 5th July, 1730, to Mr. Graham, concerning butter of antimony, and signed *F—ys*, and an appended note signed T. G. (Graham no doubt). This is followed by two pages relating to amalgamation of silver and copper, accredited to Dr. Benton—1732. This furnishes the only possible clue to the author of the manuscript, as it might possibly be that the author is this T. Graham to whom the letter was addressed; perhaps an ancestor of our famous Thomas Graham.

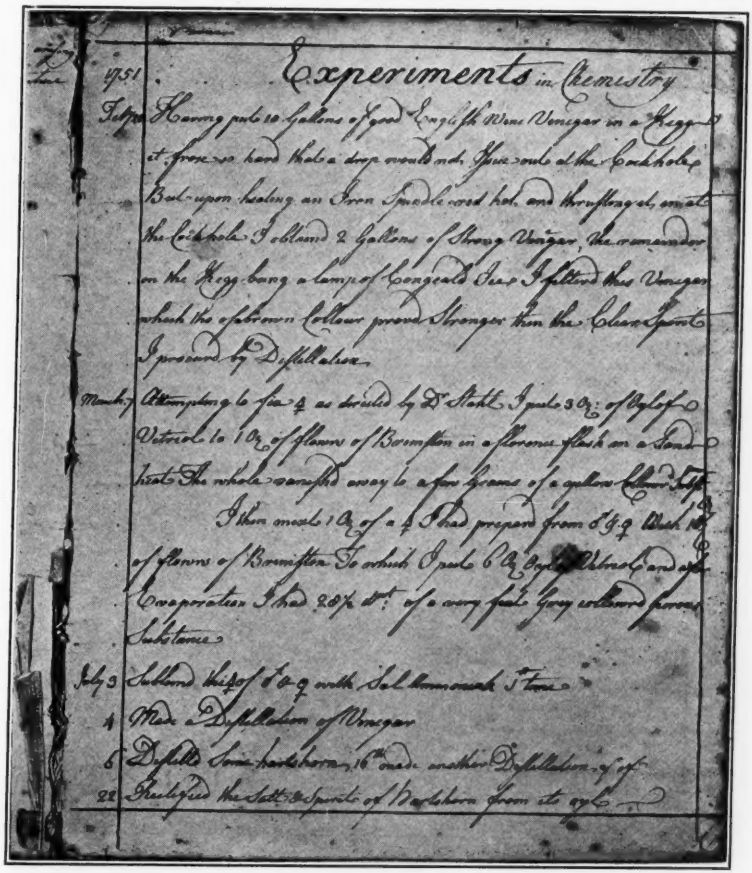
There is next inserted a record of experiments on chemistry performed by the author of the manuscript. This is given in three pages but includes dates showing the work to have been done at periods from February

[2] Copper and Iron.

20, 1751, to May 20, 1752. The alchemist symbols for the elements are used throughout this record. A part is as follows:

[*Parenthetical interpretation of symbols supplied*]

1751—Feby 20. Having put 10 gallons of good English Wine Vinegar in a Kegg it froze so hard that a drop would not issue out at the Cockhole. But upon heating an


Experiments in Chemistry

1751

Feby Having put 10 Gallons of good English Wine Vinegar in a Kegg it froze so hard that a drop would not issue out of the Cockhole But upon heating an Iron Spindle red hot and thrusting it into the Cockhole I obtained 2 Gallons of Strong Vinegar, the remainder in the Kegg being a lump of Congeald Ice. I filtered this Vinegar which tho of a brown Colour proved Stronger than the Clear Spirit I procured by Distillation.

March Attempting to fix ♃ as directed by Dr Stahl I put 3 Oz. of Oyl of Vitriol to 1 Oz. of flowrs of Brimston in a florence flask on a Sand heat The whole vanished away to a few Grains of a yellow Colour'd Substance

I then mixed 1 Oz. of ♃ I had prepared from 5 ℔ of Black Ox of flowrs of Brimstone To which I put 6 Oz. of Oyl of Vitriol and after Evaporation I had 28 ℔ wt. of a very fine Grey coloured powrey Substance

July 3 I allowd this ♃ of 5 Oz with Sal Ammoniack 3 times

4 Made a Distillation of Vinegar

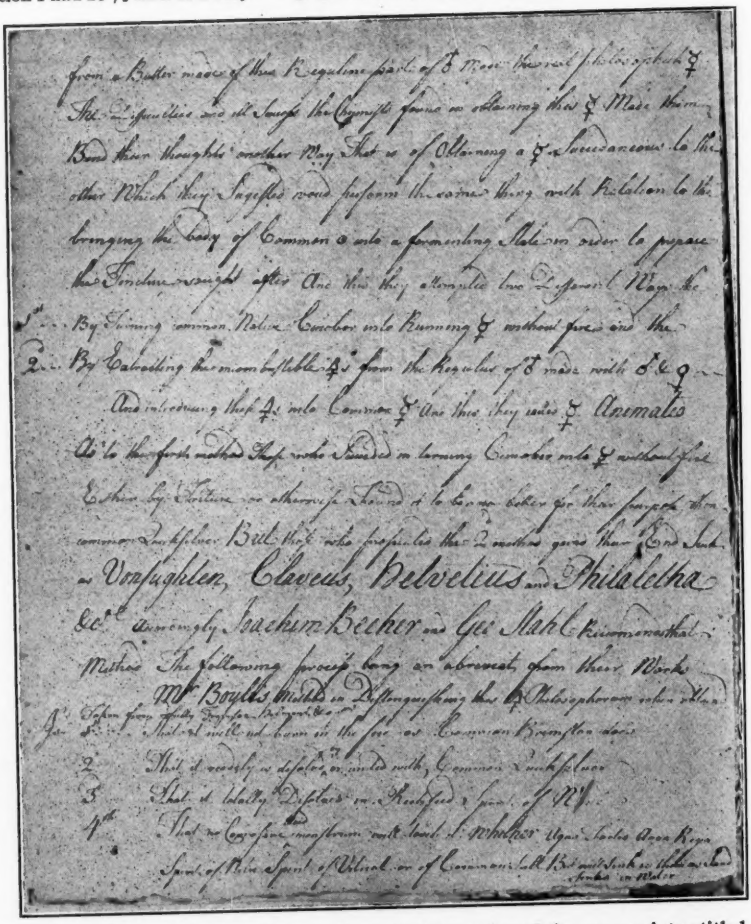
5 Distilld some Hartshorn, & made another Distillation of it

22 Rectified the Salt & Spirits of Hartshorn from its Oyl

Photographic reproduction of a page from the second section of the manuscript.

iron spindle red hot and thrusting it in at the cockhole I obtained 2 Gallons of Strong Vinegar, the remainder in the Kegg being a lump of Congealed Ice. I filtered this vinegar which though of a brown colour proved Stronger than the Clear Spirit I procured by Distillation.—Mar. 7. Attempting to fix ♃ (sulphur) as directed by Dr. Stahl, I put 3 oz. of Oyl of Vitriol to 1 oz. of flower of Brimston in a florence flask in a sand heat. The whole vanished away to a few grains of a yellow collored Substance.

I then mixt 1 oz. of a ♃ (sulphur) I had prepared from ♂ (iron) and ♀ (copper) with 1 oz. of flowers of Brimston To which I put 6 oz. Oyl. of Vitriol and after Evaporation I had 20½ dwt. of a very ——grey collored porous Substance.



Photographic reproduction of a page from the last section of the manuscript entitled "The Properties of the Philosophik Menstrums."

July 3 Sublimed the ♃ (sulphur) of ♂ (iron) and ♀ (copper) with Sal Ammoniak 5 times.

July 4 made a Distillation of Vinegar.

Following the record of experiments are seven pages of quoted matter of alchemist nature from Starkey, Kunkel, Stahl, Helvetius, and others.

The next twenty-six pages are consecutively numbered and are headed, "Chemical Collections from the Best Modern Authors Relating to Minerals and Fossile Salts." The cover of this Folio bears a similar legend and adding, "Commencing Anno 1736 to 1753." These are mostly paged quotations from the writings of Stahl, with occasional references to other authors as Becker, Paracelsus, Boerhaave, Helvetius, Basil Valentine, Roger Bacon; and others less familiar to us now, as Philaletha, Sr., Kenelin Digby, Dr. Espognet, Peter John Faber. These pages have largely to deal with animated mercury, philosophical gold, and transmutation of metals.

The last twenty pages are in a separately bound folio so finely written as to require the use of a reading glass. The penmanship shows the same identifying characteristics, however, as the other parts of the manuscript. This section is entitled, "The Propertys of the Philosophik Menstrums." It is so completely worded in the terms and in the manner of thinking of alchemy that careful study is required for its understanding. From its spelling as well as its content one would judge this to be the oldest part of the entire manuscript. It has to deal with transmutations, the philosophers' stone, and with the Universal solvent, "Alcahest," or "circulatum majus." Of this solvent it states:

> It is a universal Volatile Liquid Menstrum Dissolving all Conerets whether Animal, Vegetable, or Mineral So that all their Constituent parts may be easily Separated from one Another. Acting without Reactions of the Patient So that after 1000 operations it is as fitt for other operations as at first. In Regard It loseth neither Strength, weight or Bulk. Few of the Ancients were masters of it and the best judgers now of Chymicall Authors say That tho many of the latter Philosophers pretented to it yet non but Paracelsus, Helmont, Count Ludavuus and Starkey were possest of it.

This twenty-page discussion closes as follows:

> A modern author Says the Alcahest is Only the Oile of Salt Alembicated. But certain it is that there is a Secret previous Preparation necessary to be used with this salt Before it be turned either into Oil or Spirit So as to be made this Menstrum. It should be asked what the origin of this Sal Gemma is. The question is by the Joint opinion of all Philosophers That the Universall Spirit called Hyle produces this Acid salt which is the father of all other salts and contributes to the growth of Animals, Vegetables and minerals which fully explains this Riddle of Sendevogius.
>
> Finnis.

Science seems to me to teach in the highest and strongest manner the great truth which is embodied in the Christian conception of the entire surrender to the will of God. Sit down before the fact as a little child, be prepared to give up every preconceived notion, follow humbly wherever and to whatever end Nature leads, or you shall learn nothing.....I have only begun to learn content and peace of mind since I have resolved at all risks to do this.—HUXLEY (Letter to Charles Kingsley)

THE PREPARATION AND CHEMISTRY OF INSULIN

HORACE A. SHONLE, LILLY RESEARCH LABORATORIES, ELI LILLY & CO., INDIANAPOLIS

Introduction[1]

As early as 1856 it was known that the ligation of the pancreatic ducts caused the pancreas to degenerate without causing any symptoms of diabetes.[2] Some thirty years later Minkowski and v. Mehring[3] demonstrated that the pancreas was the seat of diabetes, when they were able to produce a diabetic condition in dogs similar to human diabetes by the complete extirpation of the pancreas. Somewhat later, it was demonstrated indirectly that an internal secretion of the pancreas was responsible for the normal metabolism of fats and carbohydrates.[4] Other investigators noted that when pancreatic degeneration occurred after the ligation of the ducts, all of the pancreatic tissue disappeared with the exception of the Islets of Langerhans.[5] It had been suggested previously that it must be these cells which produced the internal anti-diabetic secretion.[6]

During the third of a century which had elapsed since the discovery of Minkowski and v. Mehring, many investigators vainly endeavored to isolate a substance from the pancreas which would alleviate or remove the symptoms of diabetes. Practically no advance had been made until Drs. Banting and Best reported in 1922 that they had succeeded in isolating the antidiabetic hormone from degenerated pancreas.[7]

During this thirty years, numerous investigators, endeavoring to secure a direct proof of the existence of a pancreatic hormone, tested the pancreas and many pancreatic extracts of one sort or another. These preparations were usually administered to dogs rendered artificially diabetic by the removal of the pancreas, although in some instances they were given to diabetic people. Now and then an investigator reported that the use of pancreatic tissue or of an extract caused a diminution in the excretion of sugar in the urine. None of the preparations, however, could be used clinically since toxic symptoms always developed on repeated injections, and the results secured were either negative or else not favorable enough to justify their further use. The chief mode of administration of the pancreas itself or of extracts of it appears to have been by mouth. No results could have been secured by this method even if any of the extracts had been potent, since we now know that the enzymes of the alimentary tract destroy the hormone. Subcutaneous or intravenous injections of the minced pancreas or of extracts gave conflicting results which were finally interpreted as negative since the investigators one after another abandoned their experiments.

It is worthwhile to mention a few of the investigators of this period—Caparelli[8] was one of the first to report (1892) the preparation of a pancreatic extract which lessened the sugar excretion of a depancreatized dog.

Rennie and Frazer[9] gave subcutaneous injections of the separate islet tissue of the pancreas of certain bony fishes, but failed to secure favorable results.

Zuelzer (1908),[10] among other methods, minced pancreas with weak bicarbonate solutions and after allowing them to autolyze for several days extracted them. He precipitated the proteins in the extract with alcohol and concentrated the protein-free filtrate. In some instances the use of this preparation was able to alleviate part of the symptoms of diabetes but as it was too toxic for continued administrations, the experiment was abandoned. While Zuelzer carried out his extraction under conditions which favored the hydrolytic action of the trypsin, other investigators endeavored to inactivate the trypsin during the extraction without, however, succeeding in the preparation of active extracts.

E. L. Scott,[11] in 1912, attempted to eliminate the enzymes of the external secretion of the pancreas by ligating the duct just as Banting and Best later did successfully. As he did not succeed in completely ligating the ducts, he did not secure a complete degeneration of the cells which secrete the enzymes. He then made alcoholic extractions of whole pancreas and also aqueous extraction after a preliminary alcoholic extraction, but he was unable to secure a preparation capable of being administered repeatedly. There was but slight evidence that the extracts were capable of lessening the sugar output and the work was given up.

Knowlton and Starling[12] made aqueous acid extractions of the pancreas which enabled the heart of a diabetic dog to burn sugar. Since this result could not be duplicated later, the experiment was abandoned.

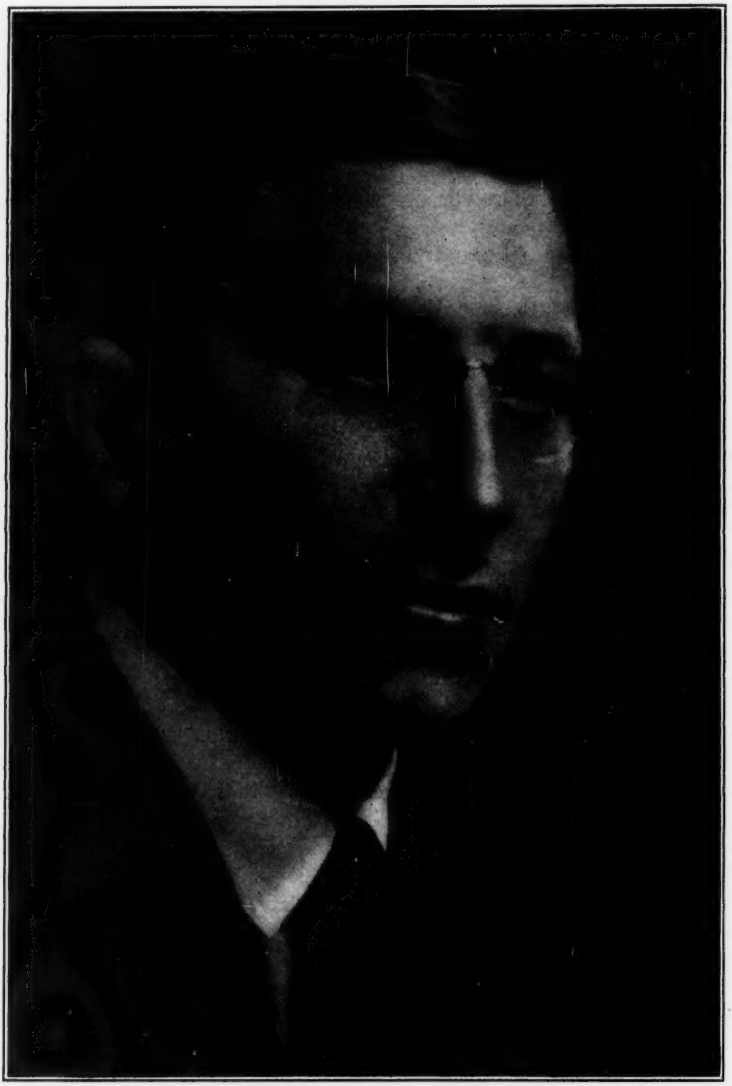
Murlin and Kramer[13] prepared aqueous acid extracts of the pancreas which were made alkaline and injected. The sugar excretion of diabetic dogs was lessened but they concluded that this was due to the action of the alkalinity of the material injected.

Kleiner[14] reported a marked decrease in blood sugar after the intravenous injection into animals of an unfiltered aqueous pancreatic extract. No attempt was made to purify the extract so that it would be devoid of toxic effects.

Exact and rapid micro methods of determining the amount of sugar in the blood had, in the mean time, been developed. By observing the changes occurring in the blood sugar of diabetic dogs after the administration of pancreatic extracts, it was now possible to determine whether or not the injected extract contained the hormone, since the presence of the hormone is shown by a lessening of the amount of sugar in the blood. Use was made of this method in the discovery of insulin.

In 1920, Dr. F. G. Banting conceived the idea that the previous failures to isolate the antidiabetic hormone from the pancreas were due to its destruction by the proteolytic enzymes of the pancreas during the process

of extraction. As stated above, by completely ligating the pancreatic ducts for a long period of time the total degeneration and disappearance of the enzyme secreting cells occurs, leaving only the cells of the Islets of Langer-



Dr. F. G. Banting, Isolator of Insulin.

hans which are believed to secrete the internal principle. He reasoned that it ought to be possible to extract the active principle of the internal secretion from the degenerated enzyme-free pancreas.

With the coöperation of Mr. C. H. Best the idea was tested out in the department of physiology of the University of Toronto under the direction of Professor J. J. R. Macleod. A simple extraction of the minced degenerated pancreas with cold saline solution gave an extract, which was capable, on injection into dogs, made diabetic by the total removal of the pancreas, of reducing the blood sugar and lessening the sugar excretion in the 24-hour urine of the animal.[7]

Similar extracts of the pancreas of foetal calves removed at a stage of development before the enzymes had formed, were similarly effective in reducing the blood sugar on injection.[15]

Extracts from normal adult pancreas made with acidulated alcohol were found to contain the effective substance. By the use of acidulated alcohol, the enzymes were destroyed and the amount of solids in the extract decreased.

With the coöperation of Dr. J. B. Collip a process for the purification of the acid alcoholic extract from the adult pancreas was perfected.[16] This process, which forms the basis for the methods now used in this country, consists of extracting the fresh minced pancreas with an approximately equal volume of acidulated alcohol, and the separation from this extract of that fraction which is soluble in 80 per cent, but not in 93 per cent alcohol. This fraction which contains the active substance also still contains a great amount of inert extracted material and must be purified until the solids are reduced to one to two per cent of the amount originally present.

The Preparation of Insulin[17]

Numerous methods have been described practically all of which are based on the extraction of the minced pancreas with an acidulated water-miscible organic solvent such as acetone, or methyl and ethyl alcohol. The use of acid or alkaline aqueous extractions has been reported favorably but other laboratories have not been able to duplicate the results, especially on a larger scale.

While the fresh pancreas of any animal will yield insulin, the pancreas of hogs and cattle are used for its commercial production. The glands, freed from fat and connective tissue, are placed in a refrigerator at the slaughter houses and transported in iced containers to prevent autolysis. On arriving at the factory they are inspected, weighed, and ground up by large power choppers. Hundreds of pounds of glands can be handled daily. The finely ground glands may either drop into an equal volume of alcohol (ethyl alcohol containing 10 per cent of pure methyl alcohol) acidified with about one per cent sulfuric acid or they may be mixed with

a quarter of their weight of acidified water and the alcohol then added. Since it is difficult to remove traces of metals from the pancreatic extract,

SCENE 1.—Before alcoholic extraction the pancreas glands are run through grinders.

enameled or earthenware apparatus must be used in every step after the glands leave the choppers.

After several hours' thorough mixing, the alcoholic extract is removed

by centrifuging in a large basket centrifuge having a rubber-lined basket. The residual gland material is removed from the centrifuge and reëxtracted with 60 per cent alcohol and this extract is likewise separated by the centrifuge.

The two extracts which are now mixed have an alcoholic content of about 60 per cent and contain fine particles of suspended glandular material. Clarification may be effected either by filtering through large funnels containing fluted filter papers or by passing it through high speed Sharples centrifuges. The clarified alcoholic extract, the acidity of which has been partially neutralized, is concentrated in hundred-gallon, steam-heated, enameled vacuum stills to about one-twelfth to one-fifteenth of its original volume. During the distillation, extreme care must be exercised to prevent overheating which will destroy the insulin. Batteries of huge rotary vacuum pumps and the use of cold brine in the condensing columns enables the thousands of gallons of alcohol to be distilled off at a temperature not exceeding 25°C.

With the complete removal of the alcohol a fat fraction separates out on warming and is removed by skimming and filtration. From this step either of the two following procedures may be used without making any marked difference in the yields.

In the method used at the Connaught Laboratories of the University of Toronto, ammonium sulfate is added to the fat-free, concentrated extract until a point of half saturation is reached.[18] This concentration of ammonium sulfate causes the insulin together with all proteins and their primary split products to flocculate out of solution and come to the surface, leaving the (lower) proteoses, peptides, etc., in solution.

The flocculent material is skimmed off, yielding about 200 grams of moist precipitate from 300 pounds of glands. This precipitate is dissolved in warm, acidified alcohol and the solution is then neutralized. This causes the insulin fraction to precipitate. After standing several days at 5°C., the dark colored supernatant alcohol, containing a considerable amount of impurities and no insulin, is discarded and the percipitated insulin fraction is dried, in vacuo, and then dissolved in acidified water. This solution is then made alkaline to a p_H of 7.3 to 7.5, at which degree of alkalinity a dark colored precipitate of inert protein material settles out and is removed. The clear solution is acidified to a p_H of 5.0 which causes the precipitation of the insulin. After standing at 5°C. for some days to insure the complete precipitation of the insulin, the supernatant liquor, containing inert materials, is discarded and the precipitated insulin is again dissolved in acidified water and again enough alkali is added to bring the p_H to 5.0, thereby precipitating the insulin. After standing at 5°C. for several days, the precipitated insulin is removed and

is now of a sufficient degree of purity to be used. This process of purification is the so-called isoelectric precipitation method.

The insulin is then dissolved in acidified water at a p_H of 2.5, to which 0.1% tricresole is added as a preservative and enough sodium chloride added to make the solution isotonic with the blood. The solution is now tested for potency on rabbits, sterilized by passing through a Berkfelt filter and ampuled.

The other methods used follow more closely the procedure of Collip.[16]

SCENE 2.—Tanks of extracted alcoholic liquid awaiting clarification by centrifuge.

After the removal of fat from the concentrated extract, alcohol is added until the concentration reaches 80 per cent. The heavy precipitate, consisting of inert protein material, is removed by filtration and is discarded. The concentration of alcohol in the filtrate is increased to 93 per cent which causes a second precipitate to form. This precipitate, which contains the insulin together with much inert protein material, is removed by filtration and dissolved in acidified water.

On the careful addition of dilute alkali to the acid solution until a p_H of about 5.0 is reached, the insulin precipitates, leaving much of the inert substances in solution. By repeating this isoelectric method of precipitation the insulin is secured of an adequate purity for clinical use. One unit of the insulin represents but 0.05 to 0.07 mg. of organic solids. The final precipitate is dissolved in acidified water to which are added 0.1% tricresole and sufficient sodium chloride to make the solution isotonic. The solution is tested, sterilized by passing through the Berkefeld filter, retested, and ampuled.

The more important of the other reported methods follow. Best and Scott,[17] who extracted pancreas with both hot and cold acidified water, found that while the method was successful in the laboratory, it could not be successfully applied to large scale production. Other investigators report similar results.

After preparing crude insulin according to Collip's procedure, Dudley[19] purified it by preparing the insoluble picrate, removing the water-soluble impurities and then converting the insulin picrate into insulin hydrochloride. Dudley and Starling[20] describe a modification of the preceding process which involves the mixing of the minced pancreas with sodium bicarbonate, followed by extraction with alcohol. By this method less inert material is extracted. The crude insulin is then purified by the picric acid method. The British Drug Houses, Ltd., are reported to make use of the alkaline alcoholic extraction method followed by the picric acid method of purification.[21] Dodds and Dickens[22] extract the pancreas with a 1 per cent formic acid solution containing 5 per cent paraldehyde. The crude insulin is then purified by the picric acid method. They also have developed a picric acid–acetone method of extraction, finding that insulin picrate is more soluble in 70 per cent acetone than are the picrates of the inert proteins which accompany it.

The method of Doisy, Somogyi, and Shaffer which has already been referred to[18] is based upon an acid alcoholic extraction of the pancreas followed, after the removal of the alcohol and fat, by a precipitation with ammonium sulfate. Maloney and Findlay[23] describe a method in which the crude insulin is purified by adsorption on charcoal. After removing the charcoal and washing, the insulin is released by alcoholic benzoic acid. Murlin[24] has found that insulin can be secured in a purified state by perfusing the pancreas with an acidified Ringers' solution.

Standardization[25]

Insulin is required for the normal burning of carbohydrates in the body, but if an excess is present in one's system, the metabolism or burning of the carbohydrate goes on so rapidly that the normal sugar content of the blood is greatly lowered. When this lowering (hypoglycemia) reaches a

certain minimum, the animal or person is seized with convulsions, which can be antidoted instantly by the administration of sugar hypodermically or orally. In rabbits, the usual test animals, the convulsions occur when the blood sugar content has dropped from the normal value of about 0.1 per cent to 0.045 per cent.

The unit of insulin is defined as one-third of the amount required to lower

SCENE 3.—Clarification of the alcoholic extract by centrifuge.

the blood sugar of a 2.0 kgm. fasted rabbit to 0.045 per cent over a period of 5 hours in 60 to 70 per cent of the animals employed for the test.

Insulin is standardized by three methods, first the amount of insulin solution required, on subcutaneous injection, to produce convulsions per kilogram of rabbit is found. Then the amount per kilogram required to lower the blood sugar to 0.045 per cent during a period of 5 hours after injection is determined. Finally the insulin is given to diabetic patients to determine actually its ability to burn carbohydrate in order to be

absolutely certain that the lot of insulin will enable the diabetic to metabolize properly the carbohydrate of his diet. As many as a thousand rabbits are used for the complete standardization of a large commercial lot of insulin.

The Chemistry of Insulin

Insulin is associated with proteins and none of the methods of purification reported have succeeded in separating an active non-protein substance possessing the properties of insulin. It is true that several investigators reported that they secured negative tests for protein in physiologically active solutions, but this was because the sensitivity of the physiological test was greater than the sensitivity of the protein test.

Since the publication of the paper with Waldo,[26] we prepared in 1924 a number of samples of insulin having a purity of 50 to 60 units per mg. and one which was active at 100 units per mg. The purification was carried out by using various modifications of the isoelectric precipitation method. It has not been found possible to secure a higher degree of purity by these methods, nor do all lots of insulin permit a purification to the degree of 100 units per mg. In the purest products tested, nothing other than protein substances could be detected. Whether insulin is itself of a protein nature or whether it is merely associated with a protein fraction of the pancreas still remains to be determined.

It was early noted by numerous investigators[27] that the physiological activity of insulin was destroyed by proteolytic enzymes, such as pepsin, papain, trypsin, or erepsin. The complexity of the protein molecule in the insulin, therefore, must be greater than that of the active principle of the pituitary gland, which is not attacked by pepsin and which Kamm[28] has shown has a molecular weight of about 1000. Definite proof is available[29,30] to show that the destruction by enzymes is due to the splitting apart (hydrolysis) of the protein molecule, rather than to an inactivation due to the formation of a physical complex of the insulin and enzymes, although the latter undoubtedly is the first step in the process of destruction by enzymes.

The insulin of commerce cannot be considered as an unaltered natural protein, since the process of extraction is such that it would undoubtedly have converted the natural proteins of the pancreas into such derivatives as acid proteins and even the higher proteoses. While purified insulin has some of the characteristics both of proteins and primary proteoses, it has seemed more fitting to us to characterize the fraction as a primary proteose. Insulin will not coagulate with heat, it will slowly dialyze through a parchment membrane, and the precipitate which occurs with the addition of nitric or trichloroacetic acid disappears on warming to reappear again on cooling. All of these tests are characteristic of the

primary protein. Insulin is insoluble in water although its hydrochloride and sodium salt are soluble just as is the case with many proteins and proteoses. It is insoluble in ether, benzene, and chloroform, but is soluble in glacial acetic acid and phenol.

Protein precipitants such as tungstic, tannic, and picric acids precipitate it. The active fraction can be recovered from these precipitates by suitable methods. Half saturation with ammonium or zinc sulfate in acid solution causes the insulin to flocculate out of solution. Insulin is readily adsorbed by kaolin and charcoal; Lloyd's reagent and positive and nega-

SCENE 4.—The separation of the final product by filtration.

tive colloids precipitate it. Since the inert substances accompanying the insulin are likewise adsorbed, it has not been possible to carry the purification of insulin very far by differential adsorption.

Insulin is slowly destroyed by boiling with 0.25 per cent sulfuric acid and rapidly destroyed by boiling in a solution barely alkaline (p_H 8.6–9.0). This destruction of activity parallels in a remarkable manner the splitting of the primary proteose molecule of the insulin into a secondary proteose.[30]

The same parallel occurs when insulin is incubated with trypsin. The slightest disintegration of the proteose molecule seems to be sufficient to

destroy the insulin. We have been unable to re-activate the insulin, if actual disintegration of the molecule has occurred. When insulin has been destroyed by any of the above methods the resulting solution gives much the same general precipitation reactions as does the original solution. Only an exact quantitative analysis will detect the distinct but slight change which has occurred in the proteose molecule.

Complete hydrolysis of the insulin to its constituent amino acids and the separation of these amino acids into groups by the method of Van Slyke has been carried out on some ten insulin samples of varying degrees of purity. It has not been possible to detect by this method any significant difference in the composition of insulin of a purity of 10 to 15 units a mg. or of a purity of 50 units per milligram, although widely different methods were used in the purification. The composition as shown by this method is similar to that of serum albumen and serum globulin and apparently only amino acids are present.

Purified insulin contains neither carbohydrate nor phosphorous. It gives a positive test for protein, a positive test for tyrosine, a positive test for histidine, a positive test for cystine, a positive test for arginine, and a negative test for tryptophane, purines, and pyrimidines. A positive test for reduced sulfur is secured after boiling the insulin with alkali. So far, then, we have found nothing which is not of a protein nature. It is possible that our purest insulin still contains such a large preponderance of inert proteose that it is impossible to obtain any test other than those for amino acids. Physiological tests often are many times more sensitive than chemical tests. Drs. Abel and Geiling[31] have purified insulin by the use of phenol and pyridine. They report that insulin readily splits off reduced sulfur on mild alkaline treatment in a manner which is not characteristic of proteins.

Insulin is readily destroyed by oxidation with dilute solutions of hydrogen peroxide or potassium permanganate. Reducing agents such as sodium bisulfite, sulfur dioxide, etc., destroy it. Murlin[32] recently reported on the recovery of the activity of reduced insulin by aeration.

Insulin is inactivated by formaldehyde, provided that the reaction occurs in a neutral medium. Iodine slowly inactivates it after first causing a precipitation. The benzoyl derivative is inactive. Treating an etherial suspension with acetyl chloride does not destroy the activity. Coupling insulin with such substances as diazotized sulfanilic acid destroys the activity.[33]

Conclusion

Dr. Banting with the coöperation of C. H. Best was able to avoid the pitfalls which checked other investigators during a thirty-year search for insulin. After successfully demonstrating its presence in the pancreas,

methods for its commercial production in a highly purified state were developed through coöperative work with an industrial laboratory. Thorough investigations of purified insulin by different laboratories have been unable to separate an active fraction free from protein, nor has careful investigation of the active proteose fraction itself shown the presence of other than amino acids—the building stones of the proteins. Insulin itself may be a biologically specific proteose, or it may be that the presence of a protein or proteose structure is necessary for the successful functioning of some substance of a non-protein nature which as yet has defied detection.

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Editor's Note: We take this opportunity of acknowledging more properly the two cuts which illustrated Dr. Geiling's article, "General Introduction to a Discussion of the Hormones," THIS JOURNAL, **3**, 41–5 (1926). These cuts were published by permission of D. Appleton and Co. We should also have noted that they originally appeared in Barker's *Endocrinology* published by that company.

Colleges Might Scout for Brains, Says Professor. Colleges might very well use the system of scouting for football stars to hunt out exceptional students who would win honors for the school with their brains, Prof. J. E. Evans, of the Iowa State College, told the American Association for the Advancement of Science.

Dr. Evans, who addressed a group of psychologists, deplored the fact that most educational institutions have concentrated on the mediocre students and have not developed the machinery which would enable them to care for the superior students who have marked individual differences.

"Attempts should be made to determine the superior students as soon as they arrive at college," said Dr. Evans. "In fact, it would be better to have advance information that such individuals are coming to the school."

Intelligence tests are a better guide to the ability of new students at a college than are their records in high-school work, he declared. Boys and girls who have won scholarships because of their fine records in high schools do not average very far above the mass of students in their college classes, statistics have shown.

Division of students into sections according to ability was advocated, so that superior students might be given enriched courses and more individual teaching. It is possible to do twice as much work in the superior section as in a section of lower grade students.

In his plea for more interest in superior students, Dr. Evans said that the colleges might even make financial concessions to such promising individuals.

"The suggestion was once made as a jest that colleges divide all students into three groups, the average students being required to pay the regular fees and tuition, the inferior group to pay twice as much, and the superior group being left free from all expense for tuition," he said. "But this statement has more sense in it than humor, for it touches directly at the money sense in American life which often gets immediate results when appealed to directly."—*Science Service*

CHEMISTRY IN THE METALLURGICAL DIVISION OF THE BUREAU OF STANDARDS[1]

H. W. GILLETT, CHIEF, DIVISION OF METALLURGY, U. S. BUREAU OF STANDARDS

Metallurgical research at the Bureau of Standards is mainly along the lines of physical metallurgy, *i. e.*, the study of the properties of metals and their alloys, rather than along those of chemical metallurgy, *i. e.*, the reduction of metals from their ores. The latter, obviously chemical, field is studied by the Bureau of Mines.

One would therefore suppose that the technical staff of the metallurgical division would be chiefly made up of men educated as metallurgists or physicists. Nevertheless the majority are men whose education was definitely specialized along chemical lines, particularly in physical chemistry. For work on many of the problems of the division it would make little difference whether one's previous training had been chiefly along chemical, metallurgical, physical, or engineering lines since all these branches of science come into play. The prime requisite is the ability to disentangle the problem into its component variables. Training in chemistry, especially in physical chemistry, fosters such ability.

There is no metallurgical problem of which the chemical side can be wholly disregarded, because the properties of metals and alloys are profoundly affected by the chemical composition and by the impurities present. For example, one problem of great importance to the automotive industry is the quality of steel for carburizing. So-called "abnormal" steel, case-hardened in the usual commercial way, does not harden uniformly. Since a camshaft or a gear with soft spots on the surface will not wear well it can be seen that the solution of the problem is of economic importance. Without attempting to predict the outcome of the still incompleted research, it appears at present that the most direct evidence as to the cause of the trouble has been given by the correlation of the "abnormality" (as shown by the propensity to soft spots and by the small grain size found in microscopic examination) with the amount of alumina, titania, or other oxides that obstruct grain growth. In this case analysis by straight chemical methods or by spectroscopic methods seems to be as essential as more purely metallurgical methods of attack.

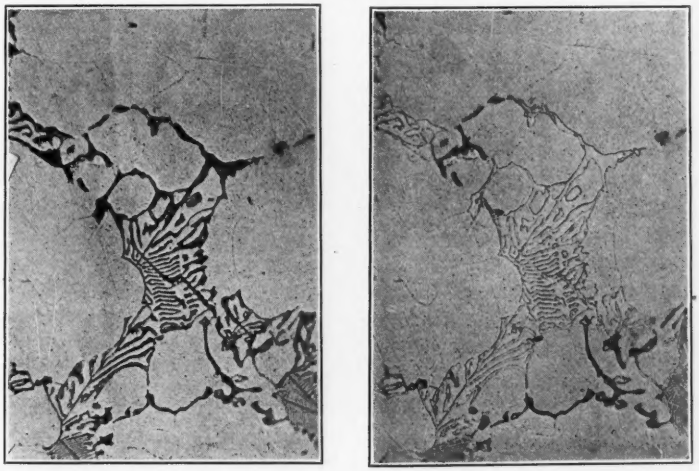
Generally speaking, however, ordinary chemical analysis is only a rough preliminary guide in the attack of problems in physical metallurgy. It is, however, an indispensable foundation, for any problem that goes back to the genesis of the metal involves the effect of composition, both as to intentionally added elements, and as to impurities. The chemistry of the steel-making process, *i. e.*, the reactions that go on in melting and refining, as well as the elimination or retention of non-metallic impurities,

[1] Published by permission of the Director of the National Bureau of Standards, Department of Commerce.

bring in many phases of physical chemistry and colloid chemistry. The colloid viewpoint aids in the understanding of the causes for the hardening of metals and alloys by heat-treatment or cold work.

Thermal analysis, the study of the heat absorbed or evolved as a metal or alloy passes through the transformation points, is of great value in outlining the heat-treatment of the material. But thermal analysis is one of the tools of the physical metallurgist by which the equilibrium diagrams of alloys are worked out according to the phase rule, and the phase rule, of course, is physical chemistry.

Another tool of the physical metallurgist is the examination of polished



A *B*

FIG. 1.—Micrographs, at 500 diameters, of the polished surface of a specimen of a high speed steel, (*A*) is etched with 10% NaOH + 1% H_2O_2. The dark areas appear to be a single constituent, but (*B*), electrolytically etched with 1% NaOH shows that there are two constituents in the dark areas. Both photographs are of the same spot.

and etched surfaces of alloys under the microscope. For the interpretation of the structures thus revealed not only must the equilibrium diagram of the alloy be known, but also the chemistry of the attack by the etching reagent. A series of publications from the Division of Metallurgy[2] deals with the behavior of etching reagents, and this is distinctly a chemical problem. (See Fig. 1.)

The differential solution of the different constituents of an alloy by a

[2] Bureau of Standards Scientific Papers 399 (10c.); 435 (15c.), also one on metallographic etching reagents for alloy steels in press.

(Bureau publications are obtainable only from the Superintendent of Documents, Washington, D. C., at the prices given, stamps not accepted.)

chemical etching reagent is useful to the metallographer. The attack upon metals and alloys by the atmosphere, by water, or by various acids and chemicals, resulting in rust and corrosion is generally far from useful and is recognized as one of the most important of present-day problems both in chemistry and metallurgy. Intensive study of the complicated and baffling problems of corrosion is being carried on by scientists in all countries. The phase in which the Bureau is especially engaged at present is the study of accelerated laboratory methods for evaluating the resistance of metals and alloys to corrosion. (See Fig. 2.) Literally thousands of tests are being made and any adequate discussion of the problem would occupy more space than a dozen articles such as this.

One corrosion problem of especial military importance is that of the

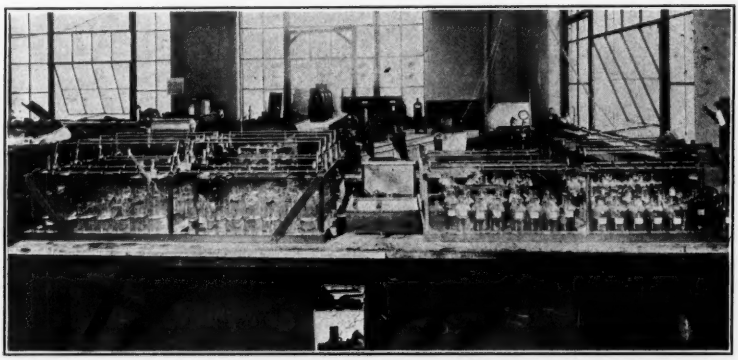


FIG. 2.—Apparatus used at the Bureau of Standards for accelerated corrosion tests of metals. The specimens are automatically alternately raised out of and lowered into solutions, to allow access of air. This usually produces more rapid corrosion than complete submergence.

intercrystalline embrittlement of duralumin, the light, strong aluminum alloy used in aircraft. Under atmospheric attack, especially in sea air, duralumin, even though protected by varnish, may undergo a type of corrosion by which, without any great attack of the surface but starting there, corrosion works in between the crystals and reduces the toughness of the material so that it will not stand bending to anywhere near as great a degree as sound material will.

The ill-fated Shenandoah was undergoing slow deterioration of this sort, as shown by the examination at the Bureau of hundreds of specimens from the wreck (see Fig. 3), although her failure is not ascribable to that cause. But in other aircraft the attack may be serious. The Bureau has been studying the problem in coöperation with the Navy, Army, and National Advisory Committee for Aeronautics for some time, since

all these agencies recognized the importance of the problem and sought to understand and prevent it, long before the Shenandoah was wrecked. The problem of intercrystalline corrosion is not confined to duralumin alone; it is met in various other alloys, so the work on duralumin should throw light on a fundamental question.

Another chemical problem is the attempt to find a silver alloy which is resistant to tarnish. Sterling silver is composed of 92.5% silver and 7.5% copper. Both these metals have strong affinity for sulfur and form black sulfides. Hence a boiled egg or even the traces of hydrogen sulfide given off from many vegetables, in cooking, will readily tarnish silverware and the housewife has to keep polishing her silver. By systematically making up alloys of silver with all the metals that will alloy with it and which do not readily form sulfides or which form light colored sulfides,

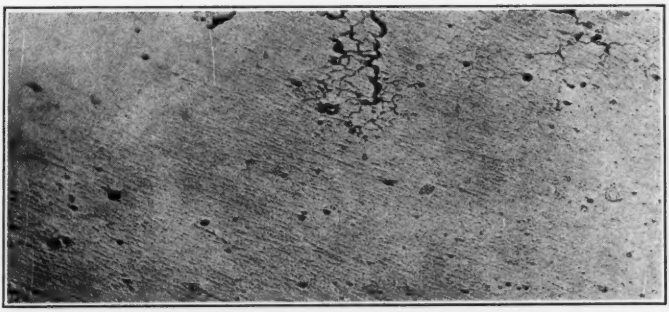


FIG. 3.—Micrograph, at 100 diameters, unetched, of a specimen of duralumin from the wreck of the Shenandoah, showing tiny branching cracks extending below the surface due to intercrystalline corrosion. The cracks look deep on account of the magnification, but are actually less than $^1/_{100}$ of an inch deep.

and subjecting such alloys to controlled attack by hydrogen sulfide, it was found that an alloy of say 80% silver and 20% zinc, or a number of other combinations, tarnish much more slowly than sterling, and can be worked into silverware. None of the alloys are entirely free from tarnish and it is unlikely that they will be substituted for sterling for ordinary use, but for special uses, such as the graduated scales on surveying instruments, they would be of decided advantage.

The heat-treatment of steel, *i. e.*, first hardening completely by heating, quenching in some liquid which will abstract the heat at a sufficiently rapid rate, and then softening or "tempering" to the desired degree by again heating, is responsible for the strength and usefulness of the steels used in the modern automobile, for cutting tools, and many other purposes. A study of the fundamentals of the quenching process is being made at the Bureau (see Fig. 4), and this involves an attempt at correlation of the

cooling properties of quenching oils with their chemical composition and physical constants. It is possible that the decomposition of a little of the oil as the hot metal is plunged into it may give rise to a gas film which surrounds the metal. The thermal conductivity of this film would affect the rate at which heat is abstracted from the metal, which is vital in the hardening process. Hence while the chemistry of the decompo-

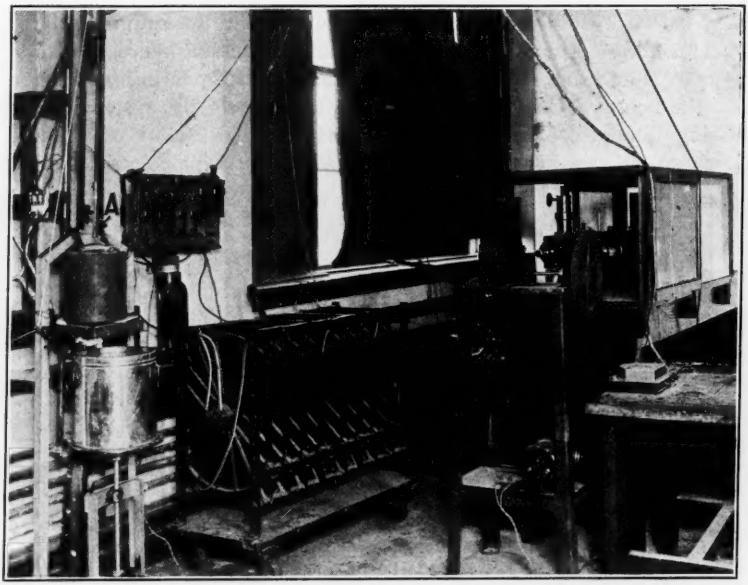


FIG. 4.—Apparatus used at the Bureau of Standards in study of the properties of quenching media. The steel specimen at *A* is heated in the furnace (just below it), then plunged into the quenching medium in the tin can below the furnace. The specimen carries a thermocouple. The Einthoven galvanometer, on the right, photographically records the temperature of the thermocouple as the specimen cools. The apparatus will record the cooling of a specimen from 900° to 100°C. in 5 seconds.

sition of various oils does not at first glance look like metallurgy, the metallurgist has to deal with it.

Some metallurgical problems are strictly chemical. For example, the determination of gases or gas-forming elements in metals is in this category. When a steel, for instance, has been analyzed for carbon, manganese, phosphorous, sulfur, silicon, nickel, chromium, vanadium, molybdenum, or other alloying elements, the whole story is not yet told. Very small amounts, usually a few thousandths of a per cent of oxygen, hydrogen, or nitrogen may also be present (see Fig. 5). Just what part these three

elements play in determining the properties of the steel is not yet certain, and cannot be told until methods of analysis are developed which will show the amounts present and the forms in which they exist.

Many metallurgists ascribe quite definite effects to the presence of these elements and it is necessary to establish the correctness or incorrectness of these claims. If they are correct, then another means of

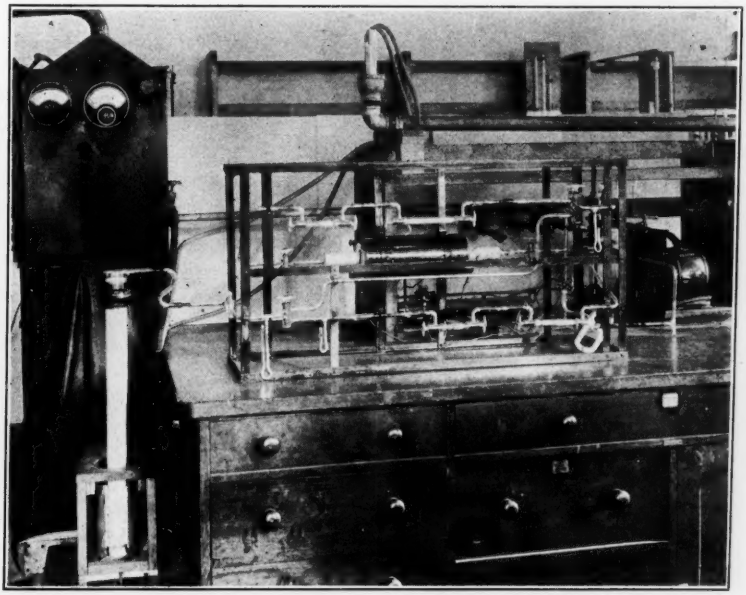


FIG. 5.—Apparatus used at the Bureau of Standards for determination of oxygen and hydrogen in metals by the Vacuum Fusion Method. The sample is placed in a gas-free graphite crucible in the bottom of the silica tube at the left. The system is evacuated by the pump at the right. By means of the high-frequency induction furnace about the bottom of the silica tube the sample is melted. The gases are caught in suitable absorbents in tubes in the train on the desk. The tubes are then detached and weighed.

controlling the properties of steel will be available. If not, we can no longer rest content with the explanation and must search for other causes for the troubles.

The analysis for such small amounts of these elements requires highly refined technique which has been described elsewhere.[3]

The Bureau is charged with the determination of the fundamental constants of materials. Since very small amounts of impurities affect the properties of metals, the study of metals of exceptional purity is a

[3] Bureau of Standards Scientific Papers Nos. 457 (5c.), 514 (10c.).

constantly recurring task in the Metallurgical Division, although most of the other divisions are likewise involved in many such problems. The

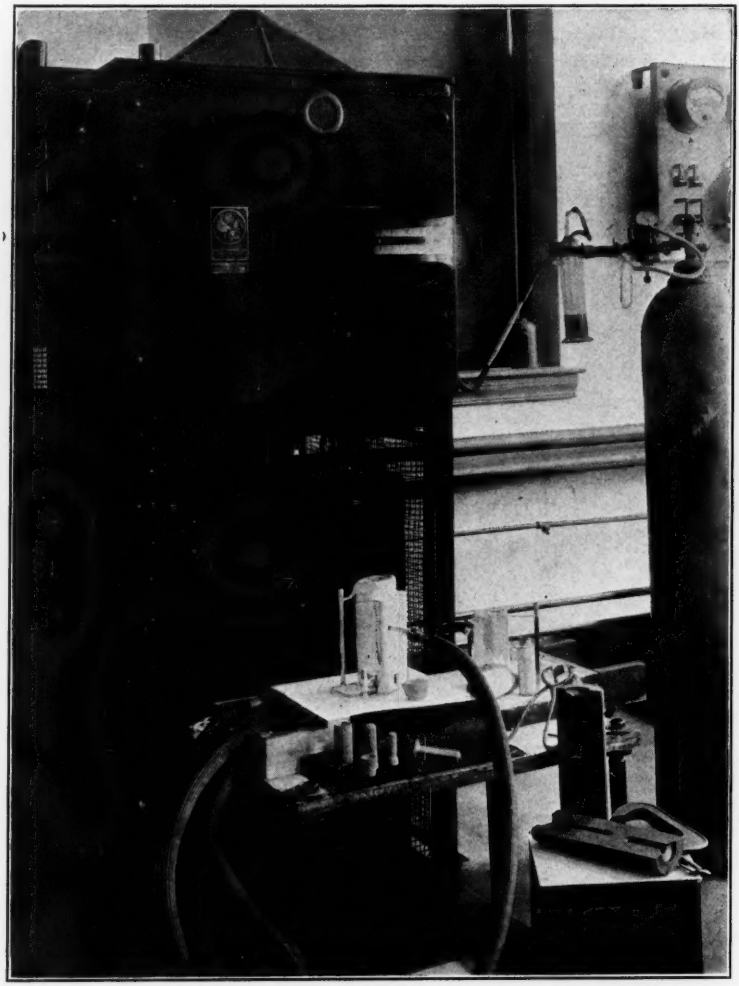


FIG. 6.—High frequency electric induction furnace used at Bureau of Standards for fusion of platinum, which melts at 1760°C. Special refractory crucibles for use in the furnace, most of them made up at the Bureau, are shown in the foreground.

Bureau has recently studied the properties of metallic zinc which is 99.997% pure. Work with the X-ray spectrometer, one of the newer

tools of the metallurgist, shows that the usual text-book statement to the effect that zinc occurs in allotropic forms is incorrect.

Work on pure iron and pure nickel is in progress, and a good deal has been done on pure platinum, a metal of very direct interest to the chemist. It is now possible to obtain platinum free from the impurities which make platinum crucibles change in weight on ignition, and this has been largely brought about through the methods developed at the Bureau for readily testing platinum for purity.[4] It is difficult to melt platinum without taking up impurities from the crucible or container in which it is

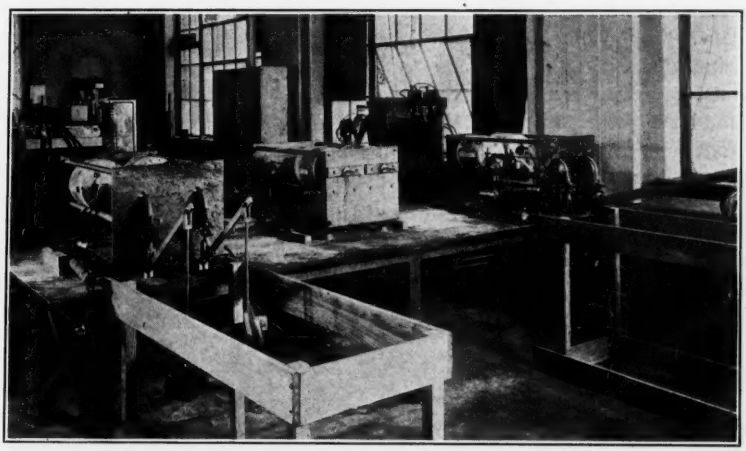


FIG. 7.—"Flow test" equipment used at the Bureau of Standards for study of the properties of metals at high temperature. Specimens are heated in electric furnaces, held at constant temperature by automatic control devices, and stressed by weights acting through a system of levers. If the specimen does not stretch, or stretches only slightly and then stops stretching, the material can be used in practice at that load and at that temperature.

melted so that special refractories and special methods of melting have had to be developed for this purpose. (See Fig. 6.)

Another problem, the properties of metals at high temperatures, which is one of the major ones now in hand, is being studied in response to the demand of the chemist for materials that can be used at high temperatures and pressures, as for example, in oil-cracking stills. Similar demands come from power plant designers, and others who would work at higher temperatures and pressures if suitable materials were available.

In this work it is often necessary to keep a specimen of a metal or alloy under load at a definite high temperature for two thousand hours or more in a single test (see Fig. 7), before its serviceability can be defined. Nat-

[4] Bureau of Standards Scientific Paper 254 (10c.).

urally every effort is being made to find methods of test which will give reliable results in a much shorter time. Equally important at high temperatures with the physical properties are the chemical properties, *i. e.*, resistance to oxidation, and to other forms of chemical attack.

This brief outline of a few of the research problems which have a distinctly chemical bearing fails to give an idea of the scope of the Bureau's metallurgical work,[5] but will serve to indicate something of the close relationship between metallurgy and chemistry.

The physicist and the chemist are prone to argue, respectively, that either physics or chemistry is the basic science and the other is merely an off-shoot. The metallurgist takes no sides in the controversy; he acknowledges his indebtedness to both sciences, for he knows that he must have a thorough grounding in both physics and chemistry to understand the principles of metallurgy and to solve the problems that confront him in his efforts to make the metallic elements and their alloys of still greater service to mankind.

[5] Letter Circular 118, "Publications from the Division of Metallurgy," obtainable on request to the Bureau, gives titles of publications and shows the scope of the work. A fuller account of the work is given in *Iron Age*, **116** (1925), p. 461, Aug. 20, p. 536, Aug. 27.

Seeks New Means of Softening Water. That hardness of water causes a great economic waste is shown by investigation of Dr. Arthur M. Buswell, chief of the State Water Survey of Illinois, and his staff of assistants who are trying to find a cheap, harmless, efficient means of softening water.

According to their investigations, the average town of 40,000 inhabitants in Illinois wastes a ton of soap daily because of the hardness of the water. Besides this waste of soap, the loss of heat because of boiler scale is enormous.

One-sixteenth of an inch of boiler scale decreases fuel efficiency ten per cent. This would be great enough, but the boiler scale in Illinois is usually from four to eight times that amount, or from one-fourth to one-half an inch, thereby decreasing the fuel efficiency forty to eighty per cent.

This efficiency of fuel is comparable to the lowering of the boiling point of water by increasing the altitude. In Mexico City, where the elevation is 7000 feet, the boiling point is 93.3 degrees Centigrade. This means that water at an elevation of 7000 feet boils at a temperature that is 6.7 degrees below the normal boiling point of water at sea level, which is 100 degrees, or, in other words, that it is 93.3 per cent efficient. The per cent of loss of efficiency is therefore 6.7. This is in noteworthy contrast with the forty to eighty per cent decrease in fuel efficiency caused by the hardness of the water in Illinois as noted above.

Fortunately, there are few states confronted with the problem of extremely hard water. Comparing Illinois with Massachusetts, we find that 300 to 600 parts per million of mineral salts in Illinois waters, while in the latter there are few over 100 parts per million of mineral salts, and none of the waters used for municipal supplies have more than 200 parts per million.—*Science Service*

BASIC PRINCIPLES OF EVAPORATION, DISTILLATION, AND DRYING*

W. H. MCADAMS, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASS.

Introduction

There are certain general basic principles applicable to all vaporization processes. These principles apply not only to the three most important operations, evaporation, distillation, and drying, but also to other vaporization processes such as humidification, dehumidification, and water cooling. However, due to the limited time available, illustrations shall be omitted regarding the application of these principles to other than the first three processes.

Basic Principles

These principles may be classified under four heads, based upon certain general laws of nature: the law of the conservation of matter, the law of the conservation of energy, the laws governing physical and chemical equilibria, and the laws of reaction rate. The first two of these are laws of universal validity and applicability and, because of this fact, are the ones to which the engineer turns first in his attack upon any problem. Science has not been able hitherto to give such exact mathematical expression to the laws of equilibrium and rate but it is none the less true that these laws are of vital importance to the engineer in the solution of the problems of chemical industry and he must use them in the best form in which he finds them available. The technique of using these principles is one of the vital necessities for success in engineering work.

To illustrate one of the rate laws let us consider Newton's law for the rate of transfer of heat under steady conditions. This law states that the amount of heat transferred per hour is determined by the product of three factors: the amount of heat-transfer surface employed, the average difference in temperature between heating medium and the material being heated, and a so-called coefficient of heat-transfer. This latter coefficient is found to be affected by a number of factors, such as the physical properties of the mediums involved, *i. e.*, viscosity, thermal conductivity, etc., the velocity of the mediums, and the dimensions of the apparatus, such as pipe diameter. In some cases temperature difference is found to be a factor, as in steam-heated evaporators. Newton's law for the flow of heat therefore determines the capacity of any apparatus as regards rate of heat supply or dissipation. The laws for the radiation of heat are also of importance, but these shall be omitted from this discussion.

* An address delivered in New York on October 1, 1925, to students at the Tenth Exposition of Chemical Industries.

The other law of prime importance is the one dealing with the rate of removal of the vapor, which for the sake of simplicity in this discussion we shall assume to be water. This law applies primarily to the case of air drying and humidification, where the vapors are evolved in the presence of an incondensible gas such as air. As a result the vaporization occurs at a temperature below the boiling point at the pressure involved. This will be further discussed under drying.

In applying these various principles to the design of commerical apparatus one must also consider the matter of expense. In general the apparatus should be so designed that the total cost of the operation is a minimum or that the profits should be a maximum.

Illustrations on the Design of Evaporators

Any evaporator must operate under predetermined terminal conditions. This means that the following factors are fixed in advance: temperature of heating medium; amount, concentration, and temperature of feed; concentration of product; and the pressure at which the evaporation is to be carried out.

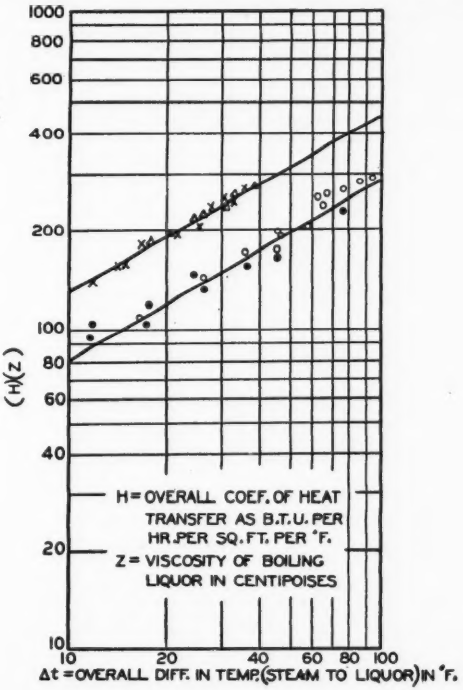
The laws of physical chemistry, supplemented by experimental physical data, give the temperature at which the solution will boil.

By applying the heat and material balances it is a simple matter to determine the amount of heat, fuel, or steam to accomplish evaporation. In order to estimate the amount of heating surface required to produce such results one employs Newton's law of heat transfer. The terminal conditions having been specified, the temperature difference, and rate of heat transfer are fixed at definite values. Hence the extent of heating surface necessary now depends wholly on the coefficient of heat transfer which in turn depends on a number of factors such as physical properties of the solution and the design of evaporator, *i. e.*, the effectiveness of the convection current in the boiling liquid. (Fig. 1.)

Instead of using one evaporator alone it is possible to use the so-called "multiple effect principle," which means that the water evaporated from the solution in the first evaporator becomes the steam supply to the heating surface in the second, and so on. In order to allow the water evaporated in the first to condense in the heating coils of the second, a difference in the temperature is necessary. Hence provisions must be made so that the solution in the second effect can boil at a lower temperature than the solution in the first, thereby requiring a lower pressure in the second evaporator. For fixed terminal conditions the use of two evaporators of a given size in series will evaporate no more than one alone, because with two in series the available temperature difference is merely divided into two parts.

As a result of placing the two evaporators in series we have increased

the fixed charges on the apparatus and have obtained no more capacity than would have been obtained with the single evaporator. On the other hand, when placing the two in series we have approximately halved the amount of steam fed to the evaporator system. Applying the principle of the economic balance we should choose such a number of evaporators in series that the sum of fixed charges and steam costs are the least. Table



• EVAPORATION OF WATER, BADGER AND SHEPARD, CHEM. MET. ENG., 23, 282 (1920)
○ EVAPORATION OF WATER, CLAASEN, ZEIT. d. VER. DUET. ING., 46, 418 (1902)
△ EVAPORATION OF WATER, TORREY AND PRATT, M.I.T. THESIS, 1913
× CONCENTRATION-TEN PERCENT SALT SOLUTION, IBID.

FIG. 1.

I, shows that under certain conditions the total charges are least for four evaporators in series. It should be realized that the optimum number varies with the cost of heating surface and of steam. If this same installation were operated only eight hours per day instead of twenty-four hours, the full saving in steam would not be realized and yet the annual fixed charges would remain unchanged. As a result one could not afford so many evaporators when operating on the eight-hour basis.

TABLE I

DAILY COSTS OF EVAPORATION

Steam at 40c./1000 lbs.; continuous operation; 285,000 lbs. of evaporation.

Number of effects	1	2	3	4	5	6
Fixed charges on evaporators	$9.60	$19.20	$28.80	$38.40	$48.00	...
Steam	134.40	67.20	44.80	33.60	26.88	...
Total	$144.00	$86.40	$73.60	($72.00)	$74.88	...
Cost per 1000 lbs. of evaporation	50.5c.	30.3c.	25.8c.	(25.3c.)	26.3c.	...

Steam at 40c./1000 lbs.; operated 8 hours per day; 95,000 lbs. of evaporation.

Fixed charges	$9.60	$19.20	$28.80	$38.40	$48.00	...
Steam	44.80	22.40	14.93	11.20	8.96	...
Total	$54.40	($41.60)	$43.73	$49.60	$56.95	...
Cost per 1000 lbs. of evaporation	57.3c.	(43.8c.)	46.1c.	52.2c.	60.0c.	...

Steam at 80c./1000 lbs.; continuous operation; 285,000 lbs. of evaporation.

Fixed charges	$9.60	$19.20	$28.80	$38.40	$48.00	$57.60
Steam	268.80	134.40	89.60	67.20	53.76	44.80
Total	$278.40	$153.60	$118.40	$105.60	($101.76)	$102.40
Cost per 1000 lbs. of evaporation	97.7c.	53.9c.	41.6c.	37.0c.	(35.7c.)	36.0c.

This principle of re-using heat may also be applied to distillation and drying. In general the more economical the apparatus as regards heat consumption, the more is its initial cost. Where vaporization apparatus is to be used in connection with a new process whose success is uncertain, it is wise to forego economy and save on initial cost. However, there are many plants in operation today where considerable savings would result by saving heat at the expense of first cost.

As already indicated, the multiple-effect principle requires a reduction in pressure in the succeeding evaporators. This reduction in pressure is often accomplished by the use of vacuum. However, vacuum is also used for another reason in evaporation, namely, because at the lowered boiling point, decomposition or injury due to temperature itself is reduced.

Illustrations on Distillation

From the equilibrium relationship between vapor composition and liquid composition, one immediately knows the concentration of vapor which a given liquid will evolve under specified conditions of temperature and pressure. In many cases this difference in concentration between vapor and liquid is unsatisfactory for accomplishing the separation desired in a single step. As a result one generally resorts to the use of a

"fractionating column," which is an apparatus for obtaining better separation than could easily be obtained in one single distillation. As shown in Figure 2, in a fractionating column, a liquid rich in the volatile component flows down the column, and vapors poor in that component flow up the column. As a result of bringing the vapors and liquids into intimate contact in such a counter-current apparatus, the vapors at each point in the column tend to approach equilibrium with the liquid at that point, thereby enriching the vapors at the expense of the liquid. With this understanding of the mechanism, it is obvious that the rich liquid should be supplied at the top of the column if good fractionation is to be secured. It is unfortunately true that in one of our large industries, the refining of petroleum, this fact is largely overlooked, and expensive fractionating columns are serving largely as vapor mains, rich liquid being practically absent. However, in the last few years a marked improvement has been noted in fractionating equipment used in this industry.

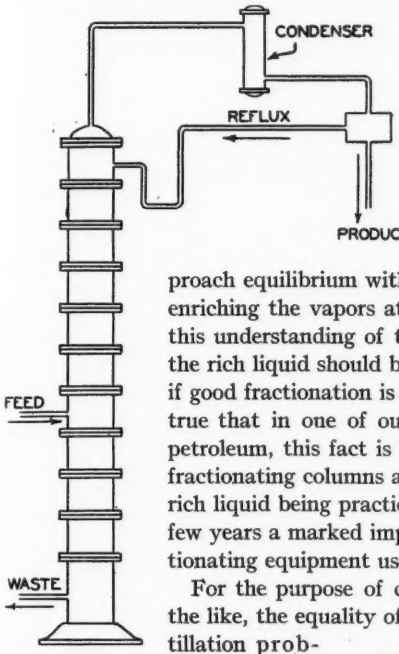


FIG. 2.

For the purpose of calculating fuel requirements, and the like, the equality of input and output is applied in distillation problems in the same way as already discussed under the design of evaporators. By making balances of material and heat and by assuming that the vapor and liquid at each point of the column reaches equilibrium, it is possible to calculate the theoretical height of the column for a given degree of fractionation. In commercial columns the contact between vapor and liquid is not sufficiently perfect to give equilibrium, and hence the commercial column must be taller than the

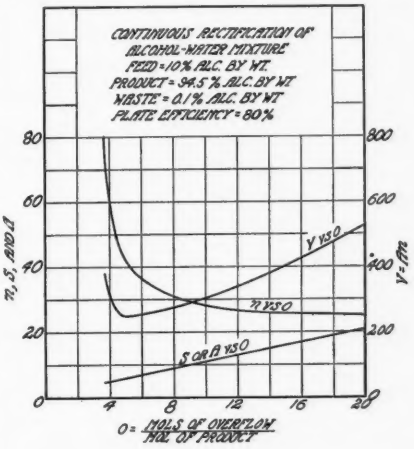


FIG. 3

theoretical one. Fortunately this ratio may be determined experimentally in columns of laboratory scale. From the allowable vapor velocities obtained experimentally one immediately obtains the cross-section

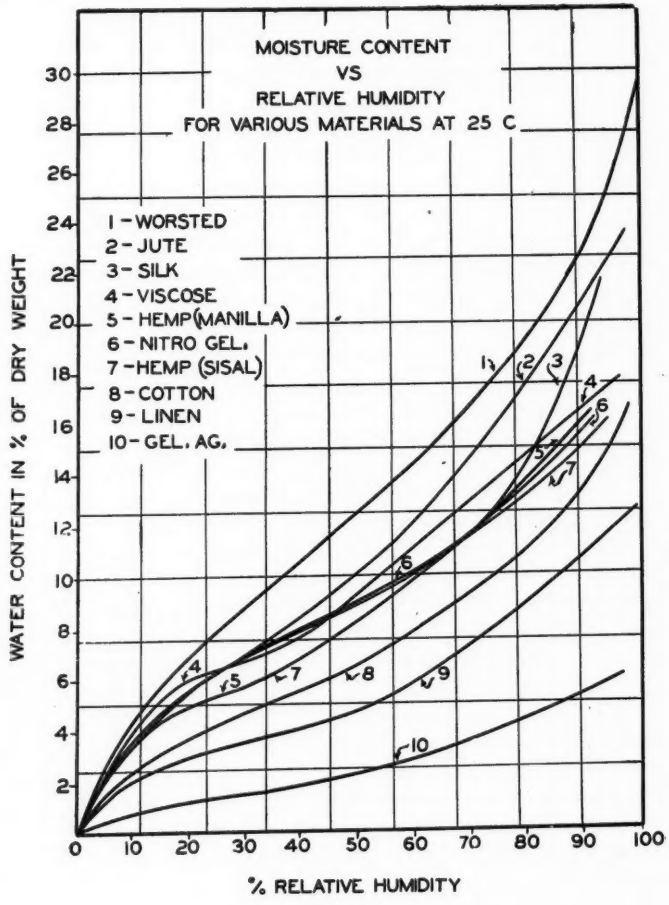


FIG. 4.

(From Wilson and Fuma, *J. Ind. Eng. Chem.* **14**, 913-18 (1922).)

to accommodate the necessary volume of vapor. As shown by Figure 3, for a fixed degree of separation one may use a tall narrow column and consume little heat, or the reverse. However, if in order to reduce the height of the column, one goes too far in increasing the amount

of rich liquid or reflux fed to the top of the column, the amount of vapor is increased to such an extent that the increase in cross-section more than overbalances the saving in height. This step would increase the total volume of the column and its cost, as well as increasing the amount of heat to be supplied, because the heat supplied at the bottom is in proportion to the amount of rich liquid fed into the top. Therefore, an economic balance between fixed charges and heat consumption need only be made for the zone in which an increase in heat consumption is accompanied by a decrease in the volume of the column, as shown in Figure 3.

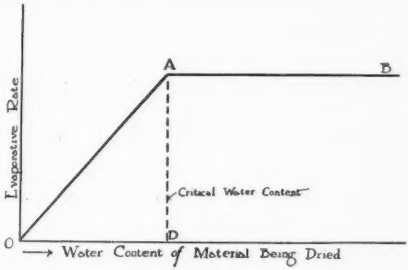


FIG. 5.

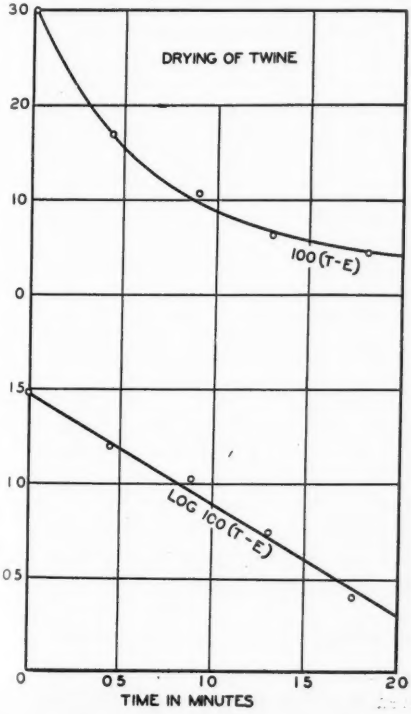


FIG. 6.

Illustrations on Drying

When a solid material containing water to be evaporated is brought into contact with air already containing some moisture, as is usually the case in air drying, it is interesting to inquire as to the lowest moisture content to which it is possible to dry the solid. Figure 4 shows the per cent of water contained in various materials as a function of the relative humidity of the air. For example, with air of 50% relative humidity at 25°C., a certain linen cloth at equilibrium will hold an amount of water equal to 5% of the weight of the dry cloth whereas worsted will hold 13%. As the humidity of the air is increased, and as the temperature is lowered, the percentage of water held at equilibrium is found to increase.

Figure 5 shows the rate of

drying of a material exposed to air of constant temperature and humidity, plotted against the water in the material expressed as a percentage of the weight of the dry material. When the percentage of water is sufficiently high the rate of drying is found to be constant. This is because under such conditions the amount of heat transferred from the air to solids is just balanced by the heat consumption in evaporating the water, the temperature of the material, therefore, remaining constant. However, when the percentage of moisture is reduced to a certain critical value, the surface of the material is no longer entirely covered with liquid water and the rate of evaporation decreases, the temperature of the material automatically rising to satisfy this lessened heat requirement.

When this point is reached, the rate is found to decrease linearly with the percentage of water until drying ceases, the per cent water being reduced to the equilibrium value previously mentioned. With this understanding of the mechanism of air drying, equations have been prepared and the assumptions tested out from experimental data. For a certain twine, Figure 6 shows that the above assumptions as to the mechanism are satisfactory, and such data form the basis of the design of commercial dryers for this material. Table II for a certain fiber board

TABLE II

RUNS UNDER TYPICAL DRYING CONDITIONS

Run No.	33	34	35	36
k	0.0029	0.0045	0.0095	0.0159
L (inches)	0.388	0.262	0.123	0.0803
kL	0.00056	0.00059	0.00057	0.00064

SUMMARY OF RUNS

Each group of the following runs is under constant drying conditions, but with varying thickness of board; all runs at same air velocity (5.93 ft. sec.)

Runs No.	1–4	5–8	9–12	13–16	17–20
kl	0.00018	0.00049	0.00073	0.00110	0.00134
p_w	3.14	7.4	11.2	14.9	19.4
$\frac{kl}{p_w - p} 10^5$	5.7	6.6	6.5	7.4	6.9

shows that the quantitative effect of sheet thickness and of humidity difference is as called for by the theoretical equations.

Summary

Before closing the following points should be emphasized:

1. The basic principles discussed are few in number and are universally applicable to the operations of evaporation, distillation, and drying.

2. In order to carry out experimental work for the purpose of collecting data to be used in designing full scale apparatus, it is important to form a mental picture of the mechanism of the process and to test, with experimental data, the assumptions made in deriving the theory.

FIRST NATIONAL SYMPOSIUM ON ORGANIC CHEMISTRY

ROCHESTER, N. Y., DECEMBER 29–31, 1925

The Symposium met in the Music Lecture Room of the Eastman School of Music on Tuesday morning. The welcome and introductory speeches were by W. R. Webb, Chairman of the Rochester Section, J. F. Norris, President of the American Chemical Society, Marston T. Bogert, Chairman of the Organic Division, and Charles H. Herty, President of the Synthetic Organic Chemical Manufacturers' Association. The rest of the morning was devoted to the two general papers of the Symposium, by J. F. Norris, on the opportunities for research in the relatively neglected field of aliphatic chemistry, and by Morris Kharasch on his work on an experimental method for determining the relative polarity of organic radicals.

Luncheon at the Chamber of Commerce gave opportunities for gathering in small groups and renewing old acquaintances and forming new ones.

The afternoon was devoted to four papers on sugars and cellulose.

Of the ten papers given on Wednesday the papers by Roger Adams on substances related to chaulmoogric acid, by John Johnston on melting points in relation to purity of organic compounds, and by J. B. Conant on some recent work in the field of free radicals excited the most discussion.

Wednesday evening an informal dinner was held at the Rochester Club. Of the short talks by officers of the Society, the Section and the Division, the most notable was that by C. L. Parsons in which he outlined the present and future activities of the Society. After the dinner the chemists occupied the Mezzanine in the beautiful Eastman Theatre and were offered a real treat in a remarkable musical and terpsichorean prelude to Mae Murray's screen version of the "Merry Widow." Once again there was much "visiting" among the chemists and some even slipped out after the prelude and "visited" some more.

The first thing Thursday morning, Harry LeBarron Gray presented to the chemists the motion pictures which he took on the A. C. S. trip to California last summer. These were complete even to the episode of the "President and the Queen" with Dr. Parsons batting for the queen.

The papers Thursday morning were somewhat rushed because of the time consumed by the business meeting. It was decided to hold the next Symposium on Organic Chemistry in December, 1927. Dr. Wm. Lloyd Evans on behalf of Ohio State University and the Columbus Section of the A. C. S. invited the Division to hold the next Symposium in Columbus. The invitation was referred to the Executive Committee of the Division for action. It was decided that the Secretary of the Division should investigate the cost of mimeographing the papers for distribution to members of the Division and others interested.

Thursday afternoon the chemists divided into groups and went on various trips. The most popular of these were to the Synthetic Chemical Department at Kodak Park and to the new Medical School of the University of Rochester. The former may be summarized by saying that any organic chemist who has never seen Dr. Clarke's plant in action is truly to be pitied. Most of the dyed-in-the-wool organizers took full advantage of their opportunity. Those whose interests took them to the Medical School saw the very latest in housing and equipment for medical education.

A TESTED METHOD OF TEACHING THE HISTORY OF CHEMISTRY*

LYMAN C. NEWELL, BOSTON UNIVERSITY, BOSTON, MASS.

Two limitations of students preclude certain types of courses in the history of chemistry. One limitation is the lack of historical background; the other is the fragmentary knowledge of chemistry. These defects in the prerequisites of a course in this field are unavoidable under our present system of college instruction. It is not possible to give a continuous or a specialized course.

During the twenty-five years in which I have taught the history of chemistry, certain facts which must be recognized in conducting a course in this subject have become evident. For example, students have little or no time, or possibly take little or no time, to read in a field which is broad or unfamiliar. General assignments usually result in general neglect. Hence any course to be successful must have specific aspects. I discovered long ago that students are interested in chemists and will read about famous men. I discovered incidentally that they remember important discoveries made by famous men, particularly if the chemist and his discoveries are definitely connected. I found also that most of the students are willing to write papers, if the subject-matter is not too difficult to obtain and the subject itself is sufficiently inviting. On the basis of these observations, accentuated no doubt, to some extent, by my own interests, I developed a course about ten years ago and have tested it definitely with large classes during the last seven years.

I abandoned at the outset all hope of giving a continuous course or even a course including what most historians would regard as essential. The general plan of my course is substantially as follows:

I give thirty-two lectures, one a week throughout the year. With a few necessitated exceptions these lectures are on famous chemists and their contributions to the history of chemistry. In each lecture I state briefly the biographical facts and then itemize and develop the contributions these men have made. Usually this consumes from thirty to forty minutes. In some cases the treatment is brief, but with a little care much superfluous or local matter can be eliminated. The aim, it should not be forgotten, is to bring to the class the essential biographical facts and the essential contributions. The class is urged to buy and read Thorpe's History of Chemistry; references are given to several other books.

The first five lectures are given without much thought of persons (though several are considered) and cover a carefully prepared account of chemistry from the days of the Egyptians to the time of Boyle. Beginning with

* Read at the Baltimore meeting of the American Chemical Society, April 7, 1925.

the sixth lecture and continuing through the course with the exception of the seventh and the last lectures, the chemist and his contributions are specifically treated. This is the list I have found most serviceable:

LIST OF LECTURE TOPICS IN A TESTED COURSE IN THE HISTORY OF CHEMISTRY

1. Greeks.
2. Egyptians.
3. Arabians.
4. Alchemy.
5. Medical Chemistry.
6. Boyle.
7. Phlogiston.
8. Scheele and Bergman.
9. Black.
10. Cavendish.
11. Priestley.
12. Lavoisier.
13. Lavoisier's Contemporaries.
14. Davy.
15. Dalton.
16. Berzelius.
17. Gay-Lussac and Thenard.
18. Dumas.
19. Avogadro and Cannizzaro.
20. Faraday.
21. Liebig and Wöhler.
22. Laurent and Gerhardt.
23. Graham.
24. Chevreul.
25. Mendelejeff.
26. Kekulé.
27. Baeyer and Fischer.
28. Ramsay.
29. Moissan.
30. Arrhenius, Raoult, and Van't Hoff.
31. Mme. Curie.
32. Chemistry in America.

It might be thought that the limited material would produce a fragmentary course. This, however, has not proved to be the case. Usually the essential connecting links can be stated in a few minutes, so that while this is a topical course, it has a certain amount of continuity.

It was obvious in the early days of this course that the students listened with satisfaction and usually went away without much intention of studying the history of chemistry. Hence, I made it an inflexible rule that at every lecture, beginning with the second, each student must hand in a paper giving a brief account of the preceding lecture. These papers are examined and toward the end of the semester are returned for use in preparing for the examination. By insisting that the papers be brief, the work of preparation, as well as the examining, is reduced to a minimum. It soon became apparent that these short papers were not highly regarded by some students. So I prepared a list of topics for more serious papers. The writing of these papers, as you will see by examining the list at the end of this article, involves considerable reading—in many cases reading of original records or reprints, and in some cases requiring an unusual amount of study. This feature of the course has proved unusually profitable. Some remarkably good papers have been submitted, *e. g.*, Scandinavian Chemists, Russian Chemists, Contemporary History, The Tree of Chemistry, and Pictures on Egyptian Tombs.

Another observation made early in the course was the necessity of exhibiting considerable illustrative material. Hence at each lecture as far as possible, I show portraits, autograph letters, books, and sometimes

lantern slides. I regard this as a vital part of the work. Students have repeatedly told me of their pleasure and profit derived from this material. Unless the portraits are expensive, I pass them about; even the autograph letters, protected by a celluloid cover, are passed about. The books are kept on the lecture table. Lantern slides are used infrequently, though in the last three years the size of the class has necessitated this method of presentation to considerable extent.

TOPICS FOR PAPERS IN THE HISTORY OF CHEMISTRY

1. Discovery of the Elementary Nature of Chlorine.
2. Gay-Lussac and His Law.
3. Priestley's "Crime."
4. Berthollet and Bleaching.
5. Development of Symbols.
6. Liebig's Contributions to Agricultural Chemistry.
7. Pasteur the Chemist.
8. Cannizzaro's Contributions to Chemical Theory.
9. The Religion of Michael Faraday.
10. Atoms, Molecules, and Electrons.
11. Electrochemistry of Berzelius and Davy.
12. Personality and Chemistry.
13. La Chimie est une Science Française.
14. Van't Hoff's Contributions to Physical Chemistry.
15. Liebig and Wöhler and Their Contribution to Organic Chemistry.
16. Dualism.
17. Laurent and Gerhardt.
18. Frankland and Williamson.
19. The Carlsruhe Convention.
20. Chemistry and the Royal Institution.
21. Scandinavian Chemists.
22. The Tree of Chemical History.
23. Paracelsus.
24. Inscriptions Showing Egyptian Contributions to Chemistry.
25. The Arrest, Trial, and Beheading of Lavoisier.
26. Stephen Hales.
27. Priestley in America.
28. The Manchester Literary and Philosophical Institute.
29. Proust.
30. Bunsen.
31. A Chronological Table of Famous Chemists.
32. Agricola.
33. Mayow.
34. Prout's Hypothesis.
35. Chaptal.
36. Dumas.
37. LeBel.
38. Sculptures on Egyptian Tombs.
39. Aristotle.
40. Basil Valentine.
41. Earth, Air, Fire, and Water.
42. Lucretius and the Beginnings of Chemical Theory.
43. Five Alchemists.
44. The Philosopher's Stone.
45. Van Helmont.
46. Geber.
47. Greek Philosophy and Its Foreshadowing of Chemistry.
48. Roger Bacon.
49. Albertus Magnus.
50. Raymond Lulli.
51. Arabian Alchemists.
52. Arnold Villanovanus.
53. The Universal Medicine.
54. Paintings of Alchemists.
55. The Alchemist in Drama.
56. Sylvius.
57. Physiology and Chemistry.
58. Grignard.
59. Sabatier.
60. Early Days of Chemistry in New England.
61. Early Days of Chemistry in Virginia.
62. The Priestley Centennial in 1874.
63. James Woodhouse.
64. Silliman.
65. Acids and Alkalies.
66. Early Days of Organic Chemistry.

TOPICS FOR PAPERS IN THE HISTORY OF CHEMISTRY (*Concluded*)

67. Hassenfratz and Adet.
68. Lothar Meyer.
69. Avicenna.
70. Boerhaave.
71. Old Forms of Contemporary Apparatus.
72. Tyrian Purple.
73. Robert Brown and the Brownian Movement.
74. History of the Term Element.
75. J. R. Glauber.
76. Robert Hooke.
77. Klaproth.
78. Lemery.
79. Epoch-Making Books in the History of Chemistry.
80. Jean Rey.
81. Boyle's Sceptical Chymist.
82. The History of Sulfuric Acid.
83. Wollaston.
85. Averroes.
86. Metals Known to the Ancients.
87. Oswald Croll.
88. Dulong and Petit.
89. Frankland.
90. A. W. von Hofmann.
91. The Discovery of Mauve.
92. Andreas Libavius.
93. Macquer.
94. Metallurgy of the Middle Ages.
95. Bernard Palissy.
96. Purple of Cassius.
97. Fredrick Accum.
98. J. B. Richter.
99. Daniel Sennert.
100. William Crookes.

LAFAYETTE COLLEGE RESEARCH PUBLICATIONS

Reprints of the papers of the Plasticity Symposium are now available for distribution at one dollar each or at seventy-five cents each for two or more. The table of contents is as follows:

Plasticity Symposium

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1. PLASTICITY. . . . . *Eugene C. Bingham*
2. EMULSION FILMS. . . . . *Harry N. Holmes*
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4. PLASTICITY OF CLAY . . . . . *Wilder D. Bancroft and L. E. Jenks*
5. THE OSTWALD VISCOMETER AS A CONSISTOMETER. . . . . *Winslow H. Herschel and R. Bulkley*
6. PLASTICITY IN RELATION TO GELATIN. . . . . *S. E. Sheppard*
7. PLASTICITY AND STRUCTURE IN GELATIN SYSTEMS . . . . . *Robert H. Bogue*
8. PLASTICITY AS APPLIED TO VISCOSE AND ARTIFICIAL SILK . . . . . *Charles S. Venable*
9. PLASTICITY IN RELATION TO CELLULOSE AND CELLULOSE DERIVATIVES . . . . *S. E. Sheppard and E. K. Carver*
10. PLASTICITY OF STARCH PASTE . . . . . *Carl Bergquist*
11. SOME OBSERVATIONS ON THE PLASTICITY SYMPOSIUM . . . . . *Frank G. Breyer*
12. PLASTICITY OF DENTAL IMPRESSION COMPOUND . . . . . *Walter S. Crowell and Albert Saunders, Jr.*
13. A SIMPLE PLASTOMETER FOR CONTROL USE WITH DENTAL CREAMS . . . . . *E. Moness and P. M. Giesy*

A list of other recent publications which are available may be had upon application.

THE FIXATION OF ATMOSPHERIC NITROGEN

H. C. HETHERINGTON, FIXED NITROGEN RESEARCH LABORATORY, WASHINGTON, D. C.

Chemists have frequently made the assertion that a nation's prosperity might be measured by its consumption of sulfuric acid. Today nitrogen consumption might afford a better measure.

For centuries the use of nitrogen compounds was confined to the fertilizing of land by the return to it of the animal and vegetable refuse of the farm. With the introduction of military explosives, the demand for nitrogen compounds began the upward climb which has culminated in the nitrogen fixation industry of today. Black powder, the first military explosive, contains a nitrogen compound, saltpeter, and the explosives since developed are even more dependent upon their nitrogen content than was the old-fashioned black powder. These explosives are no longer to be associated only with war, for in this country we now use annually about half a billion pounds in mining, quarrying, road-building, and clearing land for cultivation.

Nitrogen is necessary in many of the new and growing chemical industries of the country. Photographic films, artificial leather, imitation ivory, and dyes require nitrogen in the form of nitric acid. Nitrogen in the form of ammonia is necessary for the manufacture of artificial ice and in the operation of cold-storage plants; it is used in making soda ash, one of our most important staple chemicals, and it is found in almost every home in the form of household ammonia.

With the exception of wartime military requirements, agriculture makes the greatest demand upon our nitrogen supplies and it was largely this fact that prompted the statement of Sir William Crookes in 1898, that unless some permanent source of nitrogenous fertilizer could be found, the world would soon be facing starvation. For centuries, prior to 1830, nitrogen had been obtained in the form of saltpeter from India. About 1830, however, the huge nitrate beds of Chile became the world's chief source of supply, and although they still contain enough raw material to last for many years, the prediction of Sir William Crookes aroused a lively interest in the possibility of utilizing the inexhaustible store of nitrogen in the air, and by 1900 there was discernible the beginnings of a nitrogen fixation industry.

Many reactions of free nitrogen were known in the comparatively early days of chemistry. Cavendish, in 1781 had noted the formation of nitric acid when hydrogen was burned in air, and in 1800 Sir Humphry Davy made nitric oxide by passing air over a wire heated by an electric current. Attempts to produce ammonia directly from nitrogen and hydrogen date back to 1807 and in 1865 Deville obtained small amounts of ammonia by passing a nitrogen-hydrogen mixture through a porcelain tube heated to about 1300°C. Although these and other reactions of

nitrogen were known, the reluctance of this element to enter into combination was evidenced by the distressingly small quantities of product obtained in early work. It seemed that tremendous energy must be supplied if these yields were to be bettered; that nitrogen must be forced into combination by brute strength. This conception of the problem led to the development of the arc process, the first to be commercially successful.

The Arc Process

The arc process is extremely simple in principle, consisting essentially in passing air through a powerful electric arc, in which the nitrogen and oxygen combine to form oxides of nitrogen. These oxides are then absorbed in water to form nitric acid or in alkalies to form nitrates and nitrites. The reaction between the nitrogen and oxygen of the air is reversible; *i. e.*, if the air remains in contact with the arc, a concentration of oxides is reached beyond which the oxides dissociate as rapidly as they are formed. This decomposition proceeds very rapidly if the hot gases leaving the furnace are not cooled immediately. The production of nitric acid on a commercial basis by this process was made possible by the development of suitable furnaces in which the air would make maximum contact with the arc in a minimum of time. In all of the rather numerous types of furnace which have been developed, the principal object is to draw or spread out the arc and thus obtain as great an energy efficiency as possible. In the first successful type, that of Birkeland and Eyde, the arc was spread out by establishing a magnetic field at right angles to it. In the Schönherr furnace, a very long slender arc is maintained, while in the Pauling furnace the arc is spread out by a blast of air directed against it. Although many other types of furnace have been suggested, these three are the only ones used in large industrial plants.

The concentration of nitric oxide obtained from the different types of furnace varies somewhat but is extremely low, 1.25 per cent in the Birkeland-Eyde furnaces and 1.7 per cent in the Schönherr.

The process although extremely simple in principle, consumes an enormous amount of power, less than 2 per cent of the electrical energy consumed appearing as chemical energy in the final product. For this reason, it is possible to operate it economically only where extremely cheap power is available. In Norway several large plants are profitably operated, but other countries must conserve electrical power for purposes in which it is more efficiently used.

At present less than 10 per cent of the world's production of nitrogen fixed from the air comes from plants using the arc process.

Cyanamide Process

The commercial development of the cyanamide process started almost at the same time as did that of the arc process. That it has been far more

widely adopted than the latter is largely due to its lower electric power requirement which is about 15,000 kilowatt hours per ton of nitrogen fixed as compared with 65,000 for the arc process.

The cyanamide process is based on the fact that free gaseous nitrogen reacts with heated calcium carbide, CaC_2, to form calcium cyanamide, $CaCN_2$, essentially as represented by the following equation:

$$CaC_2 + N_2 = CaCN_2 + C.$$

The raw materials used are limestone, coke, and air. There are three principal steps in the process—the production of calcium carbide, which involves first the burning of limestone to lime, and then the fusing of the lime with coke in an electric furnace; the isolation of nitrogen from the air in a rather pure state; and finally the treatment of the finely powdered highly heated carbide with nitrogen. The crude product is a grayish black solid composed of about 60 per cent calcium cyanamide, 20 per cent free lime, 12 per cent free carbon, and small amounts of silica, alumina, etc.

The preparation of the lime is nothing more than the old familiar lime-kiln process which for years has provided the lime for building mortar, with the exception that considerable care must be exercised in the choice of limestone, which for carbide manufacture should contain smaller amounts of certain impurities than occur in many quarries worked for building lime. For example, the makers of carbide have found, by experiment and bitter experience, that too much magnesium or aluminum in the limestone decreases the fluidity of the molten carbide and interferes with the tapping of the furnace, while iron and silicon form hard lumps of ferrosilicon in the furnace.

The carbide furnaces are usually rectangular pits in which are suspended the huge carbon electrodes. The mixed lime and coke are shoveled into the furnace and at the very high temperature generated by the passage of the electric current, they react to form molten carbide, as expressed by the equation:

$$CaO + 3C \longrightarrow CaC_2 + CO.$$

The white-hot molten carbide is tapped off at intervals from a point near the bottom of the furnace, run into "chill-cars," allowed to cool and then ground to a very fine powder in which state it is ready for the final or nitrification step.

The nitrogen for the process is generally obtained by liquefying air and separating the nitrogen from the other constituents of air by the method of distillation known as rectification. Certain applications of this method which are now in disrepute in this country have made its principle more or less familiar. The nitrogen obtained is practically pure, about 99.8 per cent, and is used directly in the final step of the process.

The actual fixation of nitrogen by the cyanamide process is accomplished by bringing the practically pure nitrogen gas, under slight pressure, into contact with the finely ground carbide heated to the reacting temperature, which lies between 900° and 1100°C. The charge is usually contained in cylindrical ovens which vary in size in different plants. At the United States Nitrate Plant No. 2, the Muscle Shoals plant of which we have heard so much, each oven contains 1600 pounds of carbide.

The nitrification reaction liberates sufficient heat to maintain the mass at the proper temperature during the entire 24 to 40 hours required for complete nitrification. The final product, containing 19 to 24 per cent nitrogen as calcium cyanamide is removed from the oven, cooled and ground to a fine powder. Its use in other chemical processes will be described later.

Although the cyanamide process is less wasteful of electrical energy than the arc process, it is more so than the newer processes. It is more cumbersome than either the arc or newer synthetic processes, and would never have been adopted so widely had it not been for the wartime emergency.

It can be said for the cyanamide process that it is rugged—it could be depended upon to fix nitrogen when other methods still appeared to have a tendency to go wrong in some vital part. It served its purpose in providing a method which used less power than the arc process during the developmental stages of the synthetic ammonia processes, which are now rapidly supplanting it.

Synthetic Ammonia Process

The synthetic ammonia process is today the most important of all fixation processes. Its power requirements are only about one-fourth of those of the cyanamide process or about one-sixteenth those of the arc process, and its development thus marks our greatest advance in freeing the fixation industry from dependence upon cheap electric power.

The process is a remarkable example of the application of painstaking experimental work. Although Nernst and several other investigators made earlier contributions to the study, Prof. Fritz Haber is generally given credit for the work that directly culminated in the production of synthetic ammonia on a commercial basis, and the process naturally became known as the Haber process. Although there are today four definite forms of the synthetic ammonia process, they are essentially only variations of the original Haber process and all depend upon the fact that when nitrogen and hydrogen are brought together under considerable pressure, in the presence of a suitable catalyst, ammonia is formed according to the equation:

$$N_2 + 3H_2 \longrightarrow 2NH_3.$$

The first step in the process is, of course, to obtain the nitrogen and hydrogen gases, which must be in a high state of purity. Most frequently the two gases are obtained together from coke, air, and steam by the so-called water-gas and producer-gas methods. By treating glowing coke both with air and steam, the oxygen of the air forms carbon monoxide while the steam reacts with the coke to yield hydrogen and more carbon monoxide. There is thus obtained a gas mixture consisting essentially of nitrogen, hydrogen, and carbon monoxide. This gas is made to yield still more hydrogen by treating it with steam in the presence of a catalyst, the carbon monoxide reacting with water to form hydrogen and carbon dioxide:

$$CO + H_2O \longrightarrow H_2 + CO_2.$$

The necessary purification of this gas mixture is the most expensive step in the entire process, for the presence of more than the most minute traces of residual carbon monoxide, dioxide, or sulfur and phosphorus compounds are ruinous to the sensitive catalyst employed in the synthesis of ammonia. Most of the carbon dioxide is removed by scrubbing the gas with water under pressure; the residual carbon monoxide and dioxide are removed by scrubbing with cuprous ammonium carbonate or formate solutions.

The purified gas mixture, consisting only of nitrogen and hydrogen in the ratio of 1:3, is compressed to the desired point, which may be between 100 and 1000 atmospheres, depending on the form of process employed and is passed into the "bomb" or converter containing the bed of hot granular catalyst. Only part of the gases combine to form ammonia, the percentage conversion depending on such factors as temperature, pressure, gas velocity, and the activity of the catalyst. In various plants the conversion ranges from 8 to 40 per cent.

The catalyst is the heart of the process. Upon it depend practically all the conditions of operation, such as temperature which influences the rate of reaction, velocity of the gases through the catalyst, and even much of the mechanical design of the plant. The catalysts, most in use are essentially reduced iron containing small quantities of other materials known as promoters, which increase the effectiveness of the catalyst.

There are two quite distinct methods of handling the gases after partial conversion to ammonia. In one scheme, called the cyclical method, the ammonia is removed by condensing it and the residual gas mixture is sent back, together with some fresh gas, to the original converter. In the other method the gas is passed on through other converters in series, the ammonia formed by each being removed. Practically complete conversion is thus obtained in one passage of the gas through the series.

The removal of the ammonia may be accomplished either by scrubbing

the gases with water under pressure or cooling the gas mixture to cause condensation of the ammonia. The product of the synthetic ammonia process may thus be either aqua ammonia or anhydrous ammonia.

The three processes described are by no means the only ones which have been suggested, and even tried out on a large scale, but they are the only ones which have so far survived in the form of large commercial plants. One other method should be mentioned, the Bucher or cyanide process, in which sodium carbonate, iron, and coke are formed into briquets, heated and treated with nitrogen to form crude sodium cyanide.

Utilization of Products of Nitrogen Fixation

The direct products of all the processes described may be used directly for many purposes. In other cases they may be transformed into other products such as fertilizer salts, for which the demand is greater.

The products of the arc process, *viz.*, nitric acid and sodium nitrate, are supplemented by the fertilizer product, calcium nitrate, which is made by neutralizing nitric acid with limestone.

Ammonia is readily obtainable from the cyanamide process. In this case, the crude calcium cyanamide is treated with steam in an autoclave where the cyanamide undergoes a series of reactions the end-product of which is ammonia. Thus, we have the two most important processes yielding ammonia, one directly and the other by a simple step.

Although there are many uses for aqua ammonia and anhydrous ammonia, the greater part of this product must be marketed in some other form. Some of it may be made into nitric acid by the Ostwald oxidation process, but ammonium compounds suitable for fertilizer use are the principal outlet.

Ammonium sulfate is a familiar fertilizer ingredient, while the nitrate, phosphate, and chloride have been widely investigated from the standpoint of their usefulness as fertilizers. At present, only the sulfate and the double salt, ammonium sulfate-nitrate, are marketed to any great extent, but if the cost of phosphoric acid becomes sufficiently low, there is little doubt that ammonium phosphate will be widely used.

Urea is one of the most interesting of the newer nitrogen materials which may be derived from fixation processes. It has given splendid results in fertilizer experiments and efforts are being made in a number of countries to reduce the cost of its manufacture to fertilizer levels. It may be made from cyanamide by treating an aqueous extract of crude calcium cyanamide with a mineral acid, but the most promising method is its direct preparation from ammonia and carbon dioxide at relatively high temperature and pressure. This process can be operated to particular advantage in conjunction with a synthetic ammonia plant where there are large quantities of waste carbon dioxide available. In addition to

the above conversion products of fixation processes, the cyanamide process can be made to yield a whole series of organic compounds which although little used at this time, are of considerable interest in the field of organic synthesis.

Chemistry Aids Olive Growers. E. E. Pike, in an address delivered before the Chemical Club of Central High School, Philadelphia, Pa., stated that the green olive industry (the imported olive) is in the hands of a few families of Seville, Spain, and has continued to be in their hands for hundreds of years. During the course of the lecture, some two hundred slides were shown illustrating the growing, picking, sorting, curing, and packing of olives.

Importers of olives, according to Mr. Pike, do a $35,000,000 business yearly. Green olives are worth $180 per cask. Occasionally, it is necessary to throw as many as 300 casks into the ocean at a time because they have "gone zapatero." Zapatero is a bacterial disease of green olives which is never fatal to the consumer; but in the country where olives grow it is frequently the cause of stomach-ache. It gives the olive an odor of burning leather and a disagreeable taste. Botulinus is a disease of ripe olives which is often fatal to the consumer.

The natural acidity of the olive gives p_H 3.6 to 3.7 while olives suffering from zapatero give p_H 4.0 to 4.2. Isobutyric acid is one of several acids present. Green olives are pickled with caustic soda to remove "a bitter principle." The acids of fermentation gradually neutralize this acid and their development prevents zapatero. The combination of acids which occurs naturally and prevents zapatero also serves to hasten the fermentation of the olive. During curing, a natural soap is formed and this, the lecturer stated, together with bacterial growth is believed to be the cause of the white spots which form rings around the necks of olive bottles. The rings forming in bottles of green olives can be prevented by the addition of $^1/_8$ to $^1/_2$ per cent lactic acid. The solution of the troubles of the olive growers is not only a chemical problem but also one which the bacteriologists may help to solve. Bacteriology, Mr. Pike believes, should be included in chemistry courses.

Radiator Alcohol Dissolves Automobile Lacquer. Alcohol is a splendid lacquer solvent. Many automobile owners whose cars are finished with fine lacquers are discovering this to their sorrow. With enamels and varnishes these owners have not taken care to keep the alcohol for their anti-freeze radiator solution off the car finish. The spotting which resulted was negligible with these older forms of car finish, but with the new lacquers the results are disastrous.

Auto owners are warned by dealers selling automobiles that are finished with lacquer against allowing any form of alcohol to splash on these surfaces. In fact they must be careful that the vapor from a boiling radiator does not drift back over the engine hood. Because of these facts several builders of high-class automobiles are now recommending against any form of alcohol for anti-freeze use. Instead they recommend using glycerine or ethylene glycol solutions.

Anti-freeze solutions made from glycerine or ethylene glycol have other advantages too; from the standpoint of the automobile owner perhaps the most important is the fact that if they are accidentally spilled or boil over onto the lacquered surface no serious harm is done. The research laboratory of the largest manufacturer of moderate and high-priced automobiles in the world has made a careful study of this situation, and the subsidiary corporations are issuing corresponding information to their dealers and distributors throughout the country.—*Science Service*

THE RELIABILITY OF QUALITATIVE ANALYTICAL PROCEDURES IN THE HANDS OF BEGINNING STUDENTS

G. B. HEISIG, UNIVERSITY OF MINNESOTA, MINNEAPOLIS, MINN.

In correcting the analyses made by freshmen in a course in the qualitative analysis of cations at the University of Minnesota, the impression was obtained that certain ions were missed with considerable regularity while others were incorrectly reported as being present. In order to verify these impressions, the writer decided to record the number of times the ions of Groups IV–V were correctly and incorrectly reported in the first unknown. The results obtained were so interesting that it was decided to tabulate the reports of all unknowns.

After tabulating the results obtained, it seemed worthwhile to determine whether the procedures were really at fault, or whether the results could be attributed to the writer's poor presentation of the subject-matter. This seemed to be especially worthwhile, since a cursory search failed to reveal any published material covering the accuracy of analytical procedures in the hands of beginning students. The nearest approach is the series of papers[1] giving the experimental data upon which the Noyes analytical schemes are based. It is believed that the data following will be of general interest to teachers of qualitative analysis, and particularly so to the instructor who is just beginning to teach the subject, as it will enable him to see the troublesome spots in the procedures and to caution his students accordingly. The data should also prove valuable in suggesting points of attack for improving the procedures and confirmatory tests for the various ions; for the writer is under the impression that, in the past, attention has been especially directed toward making the procedures accurate when used by experienced workers rather than beginning students.

Additional data were then secured during the academic session of 1924–25 from reports of analyses of a small group of chemists taking a second quarter of qualitative analysis, and from large groups of students in engineering, pre-medicine, pre-dentistry, and chemistry, taking the beginning course in qualitative analysis. In addition, results of analyses made by students in 1923 were made available to the writer, and are included in the data given. At the University of Minnesota a student who presents entrance credits in high-school chemistry is required to complete successfully two quarters of work in general chemistry before taking qualitative analysis. A student who does not present high-school chemistry for entrance credit to the University is required to have credit

[1] "A System of Qualitative Analysis for the Common Elements," Noyes and Bray. Contributions from the Research Laboratory of Physical Chemistry of Massachusetts Institute of Technology Nos. 14, 23, 39. Reprinted from the *Technology Quarterly*, Vols. XIX and XXI.

for three-quarters of work in general chemistry with the exception of the engineers, pharamacists, and miners. Qualitative analysis is a required course for engineers, chemists, miners, pharmacists, pre-dents, and pre-medics. The fact that the statistics presented include work done by some students who were taking the course "for credit" and had no interest in the work other than that of meeting requirements for a degree must be borne in mind; for such an attitude must undoubtedly be reflected in their work.

The text used at the University of Minnesota is "Qualitative Chemical Analysis," by Sneed. The number of unknowns run depends on the number of hours spent in the laboratory. The writer's sections of engineers spent six hours per week in the laboratory and ran seven or eight unknowns depending on the section. The unknowns, with the exception of the last one for engineers, are solutions. These solutions are made up in a "central unknown room," and are dispensed from the stock bottle in one-ounce vials. About a third of the bottle is used for carrying out the analysis. The last unknown for the engineers' sections was a metallic unknown selected as far as possible from metallic substances used in engineering work. It has been found that a great deal of interest is stimulated in this way. The name of the material is given on the corrected report blank. The student thus becomes acquainted with the composition of at least one engineering material and probably more, because of his interest in his neighbor's sample. The results of the solid unknowns are not included in the data.

The tables and figures are based on the work of from 461–550 students depending on the particular group in the procedure, and represent tests made from 1897 times, in the case of the ions of Groups IV–V, to 631 for Group I. It is evident that an ion may be reported in one of three ways. It may have been present and found by the student. This will be referred to as being "correctly reported." The ion may have been present and not found by the student, and will be spoken of as having been "missed." If an ion is reported as present which was not in the unknown, it will be considered to have been "incorrectly reported."

Table I is a tabulation of the average results used in preparing the graphs. In Figure 1, a curve has been drawn (continuous line) in which the ions have been plotted along the abscissa, and the per cent of all students correctly reporting the ion as ordinate. In the same table similar results of the writer's classes for 1925 are indicated by a curve drawn with a broken line. An inspection of the curve shows few ions that are not correctly reported in at least 80% of the unknowns in which they occur. Therefore it would not seem unreasonable to assume that if an ion is correctly reported in 80% of the unknowns in which it occurs, the procedure and tests for that ion are sufficiently accurate for use in beginning classes. It will be seen

then that the procedures for the analysis of magnesium, calcium, zinc, aluminum, tin, and arsenic are unsatisfactory. Particularly is this true in the case of tin, which was correctly reported in only 55% of the number of unknowns in which it was present.

In order to make the results of the incorrectly reported ions comparable in all classes, the percentages have been calculated on the basis of the number of students in each class who did not correctly report

TABLE I

AVERAGE VALUES FOR RELIABILITY OF TESTS 23–25

	Number times occurred in the unknowns	Per cent correctly reported	Per cent "Incorrectly reported"	Number students	Number times tested for by all students
NH_4^+	567	84.0	1.5	553	1775
K^+	545	84.9	20.6	553	1775
Na^+	779	79.4	19.9	553	1775
Mg^{++}	397	66.7	20.3	553	1775
Ca^{++}	466	68.2	6.5	553	1775
Sr^{++}	350	86.2	4.3	553	1775
Ba^{++}	533	79.6	1.1	553	1775
Zn^{++}	530	77.5	9.3	553	1636
Cr^{+++}	290	74.1	2.2	553	1636
Al^{+++}	316	71.3	14.5	553	1636
Mn^{++}	390	81.7	2.8	553	1636
Fe^{++} or Fe^{+++}	343	86.1	12.0	553	1636
Ni^{++}	537	94.8	5.7	553	1636
Co^{++}	489	90.1	2.4	553	1636
Sn^{++} or Sn^{++++}	212	54.2	5.9	553	1131
Sb^{+++} or Sb^{+++++}	130	84.2	7.9	553	1131
As^{+++} or As^{+++++}	173	68.0	9.7	553	1131
Hg^{++}	205	85.9	7.0	553	1131
Cd^{++}	164	84.5	3.0	553	1131
Cu^{++}	376	94.0	1.5	553	1131
Bi^{+++}	225	84.1	5.7	553	1131
Pb^{++}	360	94.4	5.0	553	1455
Ag^+	254	98.8	1.1	461	631
Hg^+	274	97.2	0.7	461	631

the ion. In Figure 2, the average percentage of students incorrectly reporting the ion has been plotted against the ions and an unbroken line has been drawn through the points so obtained. The broken line connects the points obtained in a similar way for the writer's sections this year.

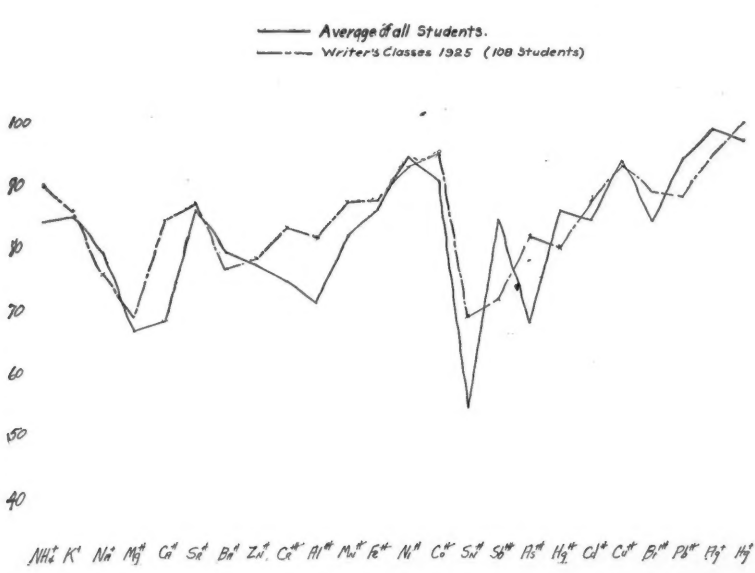
It may be seen that nearly all of the ions are incorrectly reported by less than 10% of the students who did not correctly report the ion. It seems reasonable to say that procedures, tests, etc., are sufficiently reliable in the hands of a beginner if the number of students incorrectly reporting an ion is 10% or lower. If we assume such a standard, the ordinary

tests for potassium, sodium, magnesium, aluminum, and iron are not sufficiently discriminating, and work must be directed toward improving the procedures by which they are separated, detected, and confirmed; or our chemicals contain sufficient impurities to render the tests inaccurate. The latter is not the case, for an analysis made by an experienced chemist fails to reveal the presence of sufficient impurities to warrant the ions being reported as present.

In view of the relatively large classes and number of analyses made,

Figure I

Percent of Students Correctly Reporting the Presence of Ions.


Average of all Students.
Writer's Classes 1925 (108 Students)
100
90
80
70
60
50
40
NH_4^+ K^+ Na^+ Mg^{++} Ca^{++} Sr^{++} Ba^{++} Zn^{++} Cr^{+++} Al^{+++} Mn^{++} Fe^{++} Ni^{++} Co^{++} Sn^{++} Sb^{+++} Pb^{++} Hg_2^{++} Cd^{++} Cu^{++} Bi^{+++} Pb^{++} Ag^+ Hg^{++}

together with the fact that the students were taught by five different members of the staff over a period of three years, it is believed that these results largely eliminate such factors as improper sampling of the students, etc. It is clearly recognized, however, that the average of a given section may vary from the general averages given in Figures 1 and 2 if the group of students were unusually interested or disinterested in qualitative analysis. These results serve to show where the emphasis must be placed during the lectures in order to secure greater accuracy of results, and they also indicate weaknesses in the procedure which should be improved if possible.

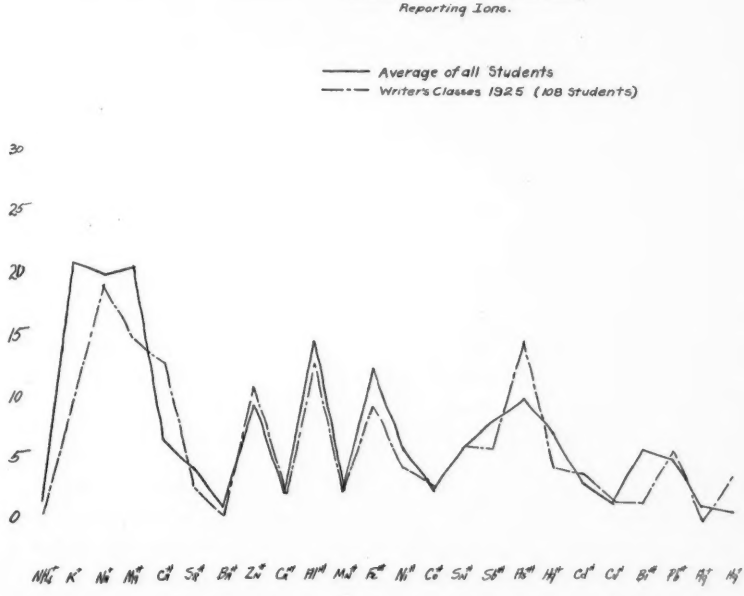
Figure 3 is a graphical comparison of the percentage of the different

ions correctly reported, obtained from the data obtained in 1924 and 1925, based on work done by the writer's own students. The results in both years are quite similar for a given ion with few exceptions.

It will be noted that there has been considerable improvement in detecting calcium ion. This is explained, in the writer's opinion, by the emphasis placed on avoiding an excess of ammonium salts. The students were told not to add ammonium chloride to the unknown solution before precipitating the ions of Groups III or IV if ammonium salts had been

Figure II

Percent of Students Incorrectly Reporting Ions.



found to be present, or if Groups II or III had been previously tested for. As an added precaution, the desirability of concentrating the solution to a small volume (10 cc.) before adding the reagent for precipitating the fourth group and the making of a flame test on the solution to give an indication of the presence or absence of the group was emphasized. If no precipitate was obtained the men were instructed to remove the ammonium salts and repeat the addition of the reagents used to precipitate the carbonates of Group IV. It was noted that quite a few students who failed to observe the precaution concerning the addition of ammonium chloride failed to get a carbonate precipitate of the fourth group and were compelled to remove the ammonium salts and add the reagents to bring

about the precipitation. It is to be noted that the percentage of the writer's students correctly reporting calcium is considerably above the average of all students, as shown by Figure 1.

Some improvement was noted in reporting aluminum ion. This is attributed to the use of the ammonium salt of aurin tricarboxylate which was used as a confirmatory test for $Al(OH)_3$.[2] The only modification made in the procedure for carrying out the test was the use of a 0.5% solution of the reagent instead of a 0.1% solution as suggested by Hammett

Figure III

Comparison of Results of Writer's Classes Correctly Reporting Ions.

and Sottery. Tests using the above reagent showed that the sodium hydroxide, sodium peroxide, and ammonium hydroxide furnished the students did not give a test for aluminum ion when used in the quantities called for by the procedure.

Beginning students seem to have considerable difficulty in finding chromium ion when a procedure is used in which the trivalent ions of Group III are precipitated with the divalent ions of the same group. The difficulty is partially accounted for by the fact that the students fail to decompose the excess sodium peroxide which is added to oxidize

[2] "A New Reagent for Aluminum," Hammett and Sottery, *Jour. Am. Chem. Soc.*, **47**, 142 (1925).

the ferrous, manganous, and chromic ions, and when the solution is acidified, the hydrogen peroxide formed reduces the chromate ion to the chromic ion. The greater part of the trouble, however, seems to be due to the fact that a white precipitate of barium sulfate is usually formed when a yellow precipitate of barium chromate is expected. The formation of the barium sulfate may be avoided by removing the sulfide ion after separating the nickel and cobalt sulfides from the rest of the ions of Group III, but beginning students rarely effect a complete removal even though they are told to use a piece of lead acetate paper to test the vapors of the boiling solution. The sulfide ion is converted to the sulfate by the action of the sodium peroxide. At the suggestion of Dr. Sneed, a small portion of the solution acidified with acetic acid which may contain chromium as the chromate ion, and zinc ion is tested for the presence of the chromate ion by the addition of a few drops of a lead acetate solution. A heavy yellow precipitate of lead chromate shows the presence of the chromate ion. Lead sulfate will not be precipitated even in the presence of considerable concentration of sulfate ion, for the ion product of lead sulfate is not exceeded on account of the very low concentration of lead ion from the slightly dissociated lead acetate. Occasionally, a white, curdy precipitate, probably a basic lead acetate, is formed, but it may be dissolved by the addition of a crystal of sodium or ammonium acetate and a little acetic acid. If the chromate ion was found to be present, the remainder of the solution should be treated with a solution of barium chloride to remove the chromate ion, and then it should be tested for the zinc ion. The treatment with the solution of barium chloride should be omitted if no chromate ion was found with the lead acetate test.

The students in 1925 show improvement over those in 1924 in their ability to identify tin. The only suggestion made to the class was that the nearly concentrated hydrochloric acid solution containing stannous chloride, after the removal of the antimonous ion by the addition of iron nails, be diluted before the addition of the mercuric chloride in order to reduce the solubility of the mercurous chloride formed in the hydrochloric acid. Calculations show, however, that if all of the stannic ion originally present in the unknown were in the solution in which the stannous ion is tested for, there would be a large amount of mercurous chloride formed above that required to exceed the solubility of mercurous chloride in concentrated hydrochloric acid. There is the possibility that some of the tin ion is lost (perhaps reduced to free tin by the nails) before making the test, and as a result only a small amount of the tin ion originally present is in the solution tested for the stannous ion.

There is some improvement shown in finding arsenic ion. This may be due to a change in the method of removing nitric acid and adjusting

the acid concentration before precipitating the ions of Group II as sulfides. Previously the students had been directed to add five cubic centimeters of concentrated hydrochloric acid to the unknown to be used and evaporated to dryness. The residue was then moistened with one cubic centimeter of concentrated hydrochloric acid, eleven cubic centimeters of water were added, and hydrogen sulfide passed into the solution contained in a pressure flask in order to precipitate any pentavalent arsenic which might be present. Beginning students have difficulty in stopping the evaporation before dryness, and it was thought that considerable loss of arsenious ion might occur by volatilization as arsenous chloride. This idea was confirmed by accidentally finding experiments carried out by Noyes and Bray,[3] in which two cubic centimeters of concentrated hydrochloric acid were added to ten milligrams of arsenic as arsenous oxide, and the solution was evaporated to two cubic centimeters. No precipitate of arsenous sulfide could be obtained from the residue. Similar experiments using arsenic oxide or oxidizing the arsenous oxide to arsenic oxide with bromine water showed no loss of arsenic by volatilization.

The students were directed, therefore, to add two drops of concentrated nitric acid to the solution of the unknown after the concentrated hydrochloric had been added in order to convert the arsenous compounds to arsenic compounds during the evaporation. Hydrogen sulfide was then passed into the solution of the unknown, one normal with respect to hydrochloric acid, which after being diluted to twenty-five hundredths normal was again saturated with hydrogen sulfide. Next year the procedure will be modified so that a small amount of ammonium iodide[4] or a small crystal of iodine will be added to the residue which has been moistened with one or two cubic centimeters of concentrated hydrochloric acid, and saturated with hydrogen sulfide after being diluted to twenty-five hundredths normal with respect to the acid added. The hydriodic acid formed will reduce the pentavalent arsenic to trivalent arsenic; in this condition it is quite readily precipitated as arsenious sulfide. The ammonium molybdate test for arsenic given in the text was supplemented by the magnesium arsenate test; but it is doubted whether the latter was used in conjunction with the molybdate test sufficiently often to warrant concluding that it was instrumental in bettering the results.

Attention must be called to the fact that in testing for cobalt nearly all of the students used special directions for separating cobalt from nickel which involved the preparation of the cobaltic salt of α-nitroso-β-naphthol instead of potassium cobaltinitrite. The figure available for the separation of the cobalt ion from nickel ion by the potassium cobaltinitrite method for a group running all unknowns was 76.2% correct

[3] Noyes and Bray, *Technology Quarterly*, **19**, 217 (1908).

[4] Reedy, "Elementary Qualitative Analysis," page 24, 1st edition.

for 81 students against an average of 95% where the nitroso naphthol separation was used. It was found that the nitroso naphthol supplied by one of the large distributors could not be used to detect cobalt in a solution which was acid with acetic and hydrochloric acids, although this is recommended by Prescott and Johnson, Fresenius, and Treadwell and Hall. It worked nicely, however, using a solution which was acid with acetic acid only. A preparation made by students in organic chemistry worked very satisfactorily in the solution acidified with both acetic and hydrochloric acids.

It will be noted from Figure 2 that the writer's students were much below the average in the percentage of students incorrectly reporting the presence of potassium ion. The percentage has remained constant for two years, and it is due to the use of a saturated solution of chrom alum as a filter for the sodium light instead of the ordinary cobalt glass.[5] A saturated solution of chrome alum was prepared somewhat above 50 degrees centigrade (the transition temperature of the blue modification of the chromic ion into the green) and allowed to cool.[6] It was then placed in a flat quart bottle, and mounted on a ring stand for use by the entire class. It has been found that such a solution will effectively screen the colors imparted to the flame by calcium, strontium, barium, and copper compounds even when they are present in rather high concentrations. Thus it is possible to check the results obtained by the systematic analysis with a flame test on the original solution. Sections not using this filter had a percentage of students incorrectly reporting potassium ion ranging from 42.5 to 20%.

The percentage of students incorrectly reporting aluminum ion has been decreased by 7% over that of last year's class (see Fig. 4) by the use of the ammonium salt of aurin tricarboxylate, for a confirmatory test. We have found the cobalt aluminate test is not satisfactory in the hands of students inexperienced in the use of a blowpipe.

The percentage of students incorrectly reporting iron has been bettered, it is believed, and brought below the average of all classes by having the students recognize the color of ferric hydroxide which is very characteristic, and omit the thiocyanate test. The reason for the omission of the confirmatory test is based on the supposition that a very small amount of ferric ion present as an impurity gives an intense color with the cyanate ion, and a large percentage of students give the intensity of the color produced in this test more weight than the volume of the precipitated ferric hydroxide.

[5] "A New Light Filter," L. W. McCay, *Jour. Am. Chem. Soc.*, **45**, 2958 (1923).

[6] Mr. W. C. Bruce found that light caused by the presence of ions of the alkaline earths was somewhat visible through a bottle filled with a solution containing the blue modification of the chromic ion.

Some improvement has been made in reducing the percentage of students incorrectly reporting bismuth by emphasizing the fact that bismuth hydroxide is reduced immediately to free bismuth by a sodium stannite solution.

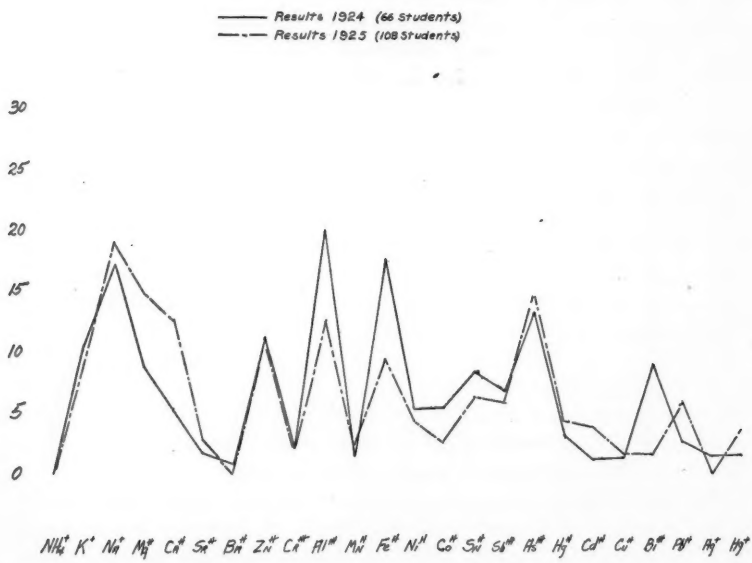
Below are several modifications of the procedures which it is believed will be found more satisfactory than the regular procedures:

Method of Dissolving the Sulfides of Cobalt and Nickel and the Sulfides of division A in group II.

The ordinary method of dissolving the sulfides of cobalt and nickel

Figure IX

Comparison of Results of Writer's Classes Incorrectly Reporting Ions.



is to treat them with aqua regia and then evaporate to dryness in order to get rid of any oxidizing agents that may be present in excess. This method is accompanied by the liberation of large quantities of acid fumes in the laboratory, and if large numbers of students are working, the room becomes nearly intolerable. This condition may be easily avoided by adding from five to ten cubic centimeters of concentrated hydrochloric acid to the sulfides, boiling, and then adding concentrated nitric acid drop by drop until the granular precipitate has disappeared, and a flocculent precipitate of sulfur has been formed. The sulfur, on continued heating, will form a molten globule which may be readily removed with

a cold stirring rod. Only a few drops of nitric acid are required to dissolve the precipitate, so there is only a small excess present after converting the sulfides to chlorides. This may be removed by boiling for a few minutes. It may be well to remark that the deep blue color present when the cobalt and nickel chlorides are dissolved in the concentrated hydrochloric acid is a sure test for cobalt.

A similar treatment works well in dissolving the sulfides of Division A of Group II. From five to fifteen cubic centimeters of dilute sulfuric acid are added; then concentrated nitric acid, drop by drop to the boiling solution until the sulfides have been converted to sulfates. The sulfur precipitate may be lifted out with a cold stirring rod, and the evaporation carried on to the formation of sulfur trioxide fumes with practically no disagreeable products being discharged into the air.

A Suggested Modification in the Test for Calcium Ion in the Presence of Strontium Ion

The solution of calcium and strontium ions, after removing the barium ion as chromate, ordinarily contains a large amount of ammonium acetate which has been added to reduce the concentration of hydrogen ions, thereby reducing the solubility of the barium chromate. If the calcium and strontium ions are to be reprecipitated as carbonates, subsequently dissolved, and the presence of each ion determined, trouble is experienced in effecting their reprecipitation as carbonates. The large concentration of ammonium ion reduces the concentration of hydroxyl ion from the ammonium hydroxide to such an extent that the carbonate ion is converted almost completely to the bicarbonate ion (due to hydrolysis). As a result, if only a small concentration of calcium or strontium ion is present, the ion product of their carbonates will not be exceeded. In this case only a partial precipitation of the ions will take place. In order to avoid the presence of as much ammonium salt as possible, it is suggested that the acetic acid be neutralized with sodium hydroxide after the removal of the barium chromate, and that sodium carbonate be added instead of ammonium carbonate. The sodium carbonate is not nearly as much hydrolyzed as the ammonium salt, and consequently will furnish a higher concentration of carbonate ion. The precipitation of the carbonates of calcium and strontium will take place more quickly and be more nearly quantitative, thus enabling the student to have a larger amount of precipitate to work with and enabling smaller concentrations to be detected.

Conclusions

1. The reports of analyses of 500 students in qualitative chemical analysis taught by five members of the staff at the University of Minnesota have been tabulated.

2. Average values for the percentage of students having an ion who correctly reported it have been given. From this data, it is concluded that the results for the determination of magnesium, calcium, zinc, aluminum, chromium, tin, and arsenic are sufficiently below the accuracy of the other ions to warrant further study and work on the procedures and tests for their determination.

3. Average values for the percentage of students incorrectly reporting an ion are given. The results indicate that potassium, sodium, magnesium, iron, and aluminum are incorrectly reported by far too many students, and work should be done to determine and remedy the causes.

4. Procedures for the determination of calcium, cobalt, aluminum, chromium, tin, and arsenic have been modified. These changes have increased the percentage of students correctly reporting the ions.

5. Changes have been made in the determination of potassium, aluminum, iron, and bismuth ions which seem to have decreased the per cent of students incorrectly reporting the ions.

6. A modification in the method of dissolving CoS and NiS as well as the sulfides of Division A, Group II has been suggested which will decrease the amount of acid fumes in the laboratory.

7. A modification of the determination of strontium ion in the presence of calcium ion has been suggested which, it is believed, will increase the accuracy of the method.

The writer wishes to thank his colleagues for their aid in securing data and for their suggestions.

Powdered Rock May Prevent Mine Blasts. Safety methods adopted by U. S. government authorities and the American Engineering Standard Committee would have prevented the recent coal mine disasters in Oklahoma and West Virginia, in the opinion of Dr. Thomas T. Reed, safety service director of the U. S. Bureau of Mines.

"The actual cause of the two blasts has not yet been determined," Dr. Reed said, "but they could not have happened if safety rules had been strictly followed. Gas and coal dust need not be allowed to accumulate and sparks and flame to set them off can be kept out of coal mines. A new method of preventing coal dust explosions by means of spraying uninflammable rock dust wherever the inflammable coal dust collects, would have stopped the explosion from traveling through the mine air.

"A mine explosion is somewhat like a gun firing," Dr. Reed added. "A flame or spark sets off the collected gas which acts like the hammer in a gun, and the exploding gas sets up clouds of dust. If the dust is of comparatively pure coal it will explode and the flame will spread through the mine air as far as the dust extends. Powdered rock sprayed about acts as a damper."

According to the American Engineering Standards Committee, about two-thirds of the fatal and serious accidents in bituminous mines could be prevented. During 1924, officials of the committee said, only one company in America practiced rock dusting on any large scale. At present, however, over 200 mines are rock dusted, but this is only about 4 per cent of all the soft coal mines in the United States.—*Science Service*

A SET OF BORAX BEAD STANDARDS

EARLE R. CALEY, MONROEVILLE HIGH SCHOOL, MONROEVILLE, OHIO

Teachers of elementary chemistry and qualitative analysis are frequently busy persons during the laboratory periods. Much of this activity consists in answering the same kind of questions propounded by as many different pupils as the laboratory contains. Much of this questioning is, of course, necessary and is a helpful part of the educative process. Some of it, however, especially the kind involving the teacher's confirmation of the color of precipitates, flames, borax beads, and similar things, is needlessly repetitive and takes away much of the teacher's time that could be spent with more profit in other directions. Certain mechanical aids can be used as time-saving devices to remedy this difficulty. As a single illustrative example of this kind of a teacher's aid, there is described here a set of borax bead standards which is to be prepared and hung up in a prominent place in the laboratory so that the pupils may consult it, instead of asking the instructor about the colors of beads that they have obtained. In addition to saving the teacher's time this device permits the pupils to consult a surer guide, Nature herself, for a check on their own work.

It may be thought, at first hand, that the only operations needed in order to prepare a set of borax bead standards are: to make the beads using a platinum wire and suitable metallic compounds, to let these specimens cool, and then to place them in a glass-covered cardboard box or container. In practice, however, it is found that beads left in contact with the moisture of the atmosphere soon lose their luster and even their characteristic color. The beads must be preserved in small glass tubes. The entire process is therefore described in detail.

A number of glass tubes about three centimeters long and one-half centimeter in diameter are first cut and sealed at one end in the usual way. These serve as the containers for the prepared beads. The beads, themselves, are best made by using a blast lamp. By this means, beads showing perfectly the characteristic oxidizing and reducing colors can be prepared. Near the blast lamp should be placed a glazed porcelain evaporating dish, of large size, which must be perfectly clean and dry. The borax bead is then made in the usual manner, using a looped platinum wire and metallic salt solutions. When a satisfactory bead has been obtained, the wire holding it is tapped on the side of the porcelain dish, to detach the bead which rolls down the side of the dish and takes on a perfectly spherical shape. The bead thus formed should, at once, be placed in one of the glass tubes, the other end of which is then quickly sealed in the blast flame. Beads prepared in this manner retain their original luster and color indefinitely. At least two beads for each metal should be prepared, one showing the color under oxidizing conditions,

the other, the color formed in the reducing flame. Other beads of each kind may also be made, if desired, showing the effects of different quantities of metal present upon the color of the borax bead. The set of borax beads, so prepared, should be mounted with suitable labels upon a card, or better yet, in a small glass-covered wooden case. In the latter case the tubes are conveniently held in place with cotton wadding.

The use of laboratory standards, can, in this manner, be readily extended to other topics by the resourceful chemistry teacher. The use of standards is not only a time-saving device for the teacher, but is also desirable from the pedagogical standpoint. It is all too easy for the pupil to get into the habit of continually asking questions about the colors and other qualitative aspects of substances he has prepared or obtained in tests. And it is also easy for the teacher to get into the habit of affirming the pupil's results in this regard. In this way the pupil gets to rely upon the authority of the teacher instead of the authority of Nature; and it is the authority of the latter that the pupil must be made to rely upon if we are ever to hope to inculcate something of the scientific attitude and spirit, as one of the results of our secondary school courses in chemistry and other sciences.

Chemist Approaches Synthesis of Leprosy-curing Substance. A simple derivative of chaulmoogric acid, one of the components of an oil used for centuries in the treatment of leprosy, has been made synthetically by Prof. Roger Adams of the University of Illinois.

Dr. Frederick B. Power of the U. S. Bureau of Chemistry, who first investigated the healing power of chaulmoogra oil more than twenty years ago, and who prepared the same substance from the natural oil that the Illinois professor has now prepared synthetically, said that future experiments would prove or disprove its value.

"No information is yet available regarding the physiological action of the synthetic compounds," Dr. Power said, "and their medicinal value in the treatment of leprosy can therefore not be determined until they have been submitted to appropriate tests."

The chaulmoogra oil, from which these acids that Dr. Rogers is attempting to make artificially are produced, is squeezed from the seeds of an East Indian tree known to botanists as "Taraktogenos kurzii." The oil has a very disagreeable taste and is not easily tolerated by the patients because of the stomach disturbances it produces. By using modifications of the acids which Dr. Power first isolated, this difficulty was largely overcome, because these substances could be injected into the muscles.

Leprosy is an ancient disease which has not yet been conquered, for it is still widely distributed over all tropical and temperate regions. No nation is wholly free from it. The exact number of cases in the world today is not known, but conservative estimates place it at from one to two millions.

In 1909 there were believed by different medical authorities to be between five hundred and two thousand cases in the United States. It is a slowly infecting disease, which, with better sanitary regulations and therapeutic methods, should be easily stamped out. In this connection the work of Dr. Adams will be watched with interest.
—*Science Service*

THE USE OF GOOD NOMENCLATURE IN TEACHING CHEMISTRY

E. J. CRANE, CHAIRMAN, COMMITTEE ON NOMENCLATURE, SPELLING, AND PRONUNCIATION OF THE A. C. S.

It is desirable for chemists to be careful in their choice of chemical names when reporting work just as it is desirable for them to be careful in the laboratory. Exactness should characterize scientific statements just as faithfully as it should characterize scientific experimentation; often it does not do so. The teacher of chemistry is in an ideal position to help bring about improvement in this respect. If chemical students get started right they are very likely to continue to use good nomenclature as their activities increase. It has been said that too often teachers themselves are careless in their use of chemical names. This appears to be true and it has therefore seemed a proper step to urge greater attention to this phase of their teaching qualifications and to suggest that emphasis to students of the importance of using clear and exact terminology is needed and is likely to bear good fruit.

The use of good chemical nomenclature is a cultural attainment. The all-round scientist takes pride in making every phase of his work truly scientific. His discourse and his papers are not slovenly in any respect. He expresses himself clearly. He chooses his words, particularly his scientific words. He avoids ambiguity and other sources of confusion. He endeavors to leave no possibility of doubt as to the meaning of what he has to say. And even if clearness is not at stake he prefers to follow best usage. It is partly a matter of good English. The meaning of "ain't" is generally clearly understood but the good teacher does not use the word. In very much the same way it could hardly be considered good English to use chemical names which depart from standard approved usage. It is not good practice, for example, to use the word "body" when one means "compound," to use "toluol" for "toluene," "sulfocyanide" for "thiocyanate," "brombenzene" for "bromobenzene," "oxyacetic acid" for "hydroxyacetic acid," "acetic ether" or "acetic ester" for "ethyl acetate," and so on. Teaching is a cultural activity. Conscious effort on the part of the teacher to use good chemical nomenclature is desirable on that account also.

Best usage is not essentially predominant usage in chemical nomenclature although it is recognized as a good principle to depart from accustomed names only when there is a good and sufficient reason for so doing. In the efforts of nomenclature committees to bring order out of chaos and to establish standards it has been advisable to work out certain guiding principles, with recognition of natural classifications (name endings, as the "ol" ending for alcohols, are usually employed to designate classes), and this has meant that accustomed names have had to be altered at

times. Clearness of meaning has been the main consideration; *e. g.*, the name "ethyl acetate" is preferable to "acetic ether" or "acetic ester" for the compound $CH_3COOC_2H_5$ because it tells exactly what the compound is; the compound is not an ether at all and, taken literally, the name "acetic ester" really means any ester of acetic acid. Suitability for indexing is another consideration of importance. It is not the purpose here to go thoroughly into this question of reasons for preferred names but it has seemed appropriate to emphasize the fact that there are reasons which it is thought are sufficient to overcome the natural reluctance which most of us have to give up accustomed practices.

To the teacher who wishes to check up on the chemical nomenclature which he uses it is suggested that the following sources of information should prove helpful.

1. Webster's New International Dictionary (G. & C. Merriam Co.). Dr. Austin M. Patterson is responsible for the chemical terms in this dictionary and he is beyond a doubt America's best authority on chemical nomenclature.

2. The subject indexes to the *Journal of the Chemical Society* (London) (beginning with January, 1926, the abstracts formerly appearing as a part of this journal are to appear in a separate publication known as *British Chemical Abstracts*) and to *Chemical Abstracts*. In these journals great care is taken to keep the nomenclature good and since they are abstract journals the indexes, particularly the collective indexes, contain entries for a great many compounds. The Formula Index to *Chemical Abstracts* (published annually since 1920) serves as a guide to the Subject Index of this journal. The Introduction to the Subject Index of *Chemical Abstracts* contains some helpful information in the form of a statement of the principles followed in the systematic naming of organic compounds for entry in the index and in the form of lists of names of organic radicals. The Ring Index, which is a part of this Introduction each year, is a great help if one is interested in determining the names of ring compounds. The Introduction has been published annually since 1916 and is to be found also in the Decennial Index.

3. Directions for Assistant Editors and Abstractors of *Chemical Abstracts*. Nomenclature rules are included. Copies can be obtained from the office of *Chemical Abstracts*.

4. The Roscoe and Schorlemmer "Treatise on Chemistry." It is a good standard for inorganic compounds.

However certain the facts of any science, however just the ideas derived from these facts, we can only communicate false or imperfect impressions to others, if we want words by which these may be properly expressed.—A. L. LAVOISIER

CHEMICAL FRATERNITIES*

JOHN H. GARDNER, WEST VIRGINIA UNIVERSITY, MORGANTOWN, W. VA.

It has been said that a group of four college students suddenly stranded on a desert island, within the first half hour would choose a name of three Greek letters, and elect a president, vice-president, secretary, and treasurer. That this statement of the tendency of students to organize is not greatly exaggerated can be judged by a cursory examination of the number of badges seen on the students of any American university or college.

In recent years there has been an increasing tendency to organize honorary and semi-honorary societies according to the students' major subjects. There are fraternities in agriculture, engineering, journalism, medicine, law, and almost every other university department. Needless to say, chemistry is no exception. The chemistry teacher can safely conclude that sooner or later his students will form some sort of organization, and that his best plan will be to lead them in the best path to follow.

Departmental organizations may be divided into two principal types, clubs and fraternities. A departmental club, in general, automatically takes into its membership all students majoring in the department regardless of their scholastic standing or character, while a fraternity is limited in its membership to those chosen by the members on a basis of scholastic standing or personality or, preferably, both. The club merely appeals to the student's interest in his chosen field, often very slight in undergraduate days, but the fraternity adds the appeal of its exclusiveness and the mystery of its supposed secrets (which are usually non-existent). Furthermore, because of its exclusiveness, students regard membership in any kind of a fraternity as an honor. As a consequence, a fraternity can be eminently successful in a department which will fail utterly to support a club.

Chemical fraternities are generally classed as honorary or professional. The membership of the former type is selected primarily on a basis of scholastic standing, ordinarily the highest fourth of a class being eligible, personality being a secondary consideration, and frequently being entirely neglected. In the professional fraternity, on the other hand, character is the principal factor in the selection of members, with better than average scholarship as a second requirement. An honorary society is ordinarily limited in its membership to students in the junior year and beyond, while a professional fraternity may extend to the sophomore class. It is obvious that the honorary fraternity has a much more limited number of students to choose from in selecting its members than does the professional.

* From a paper presented at the Symposium on Chemical Education at the University of Maryland, July, 1925.

It can safely be said that a fraternity of any kind can only be successful in an institution large enough to maintain a chapter of at least ten members. Consequently, it is scarcely practical for a small college to attempt the organization of an honorary society, unless the standards are to be so loose as to make the term "honorary" a mere farce. However, a school graduating an average of ten students a year in chemistry or chemical engineering can readily support a professional fraternity if the students and faculty take a real interest in the project. Faculty support and encouragement is, in the writer's experience, always essential for the welfare of a departmental fraternity.

One unfamiliar with the purposes and methods of chemical fraternities may well ask if there is any reason for encouraging them; if it would not be better to organize clubs which are merely undergraduate seminars. Any member of a chemical fraternity will answer these questions without hesitation, and there are few, who, knowing the nature of fraternities, will ever prefer the departmental club.

The principal argument in favor of the fraternity is that members of the chemical profession, as of any other, are human beings first, and chemists, students, and teachers afterwards. Consequently, they can do better work if their natural desire for the society of people with common interests and congenial natures is first satisfied. The primary function of a fraternity is to fill this need. The fraternity provides what the departmental club never can, an entirely informal meeting ground for students, faculty, alumni, and visitors from the outside. It makes an astonishing difference in attitude when the students call the gray-haired department head "Brother" instead of "Professor."

In many institutions, chemical fraternities are doing much for the benefit of the department, and the institution, in general. They give open meetings at which speakers from the outside bring in a broadening influence; they present moving pictures on chemical subjects; they give smokers, dances, and other social affairs, and, in general, help to produce a spirit of good fellowship by bringing together members of the department away from the formal atmosphere of the class-room.

Opponents of fraternities charge them with producing a spirit of snobbishness among the members. It is claimed that fraternities divide the student body into cliques, the members of which consider themselves too good to associate with those who do not belong. The writer, however, has found chemical fraternities, and others as well, with very few exceptions, to exert just the opposite influence. The intimate association of the fraternity forces the member to recognize the good points of men who differ with him on many subjects. The result is a broadening of his ideas concerning his fellow men and a greater tolerance of other opinions. The college student is nearly always snobbish and intolerant of those

who differ with him. A properly functioning fraternity helps greatly in making him realize that others have ideas as reasonable as his own.

Up to this point, the discussion has been confined entirely to the local aspects of the fraternity. However, a local fraternity will rarely be regarded as satisfactory by a group of students. They wish to be closely connected with other institutions by virtue of membership in a national organization, and to belong to a fraternity which will mean something to them after graduation, as well as before. These aims are well met by existing national fraternities, as is witnessed by the loyalty and interest shown by many members after graduation.

Our national fraternities are to an increasing extent organizing alumni or professional chapters in the larger cities, extending their influence into the groups of members in the industries and in business. Every meeting of the American Chemical Society includes among the social events, meetings of several chemical fraternities, in which the main aim is not chemistry but the good fellowship of chemists.

Upon visiting either his own or any other chapter of his fraternity, the alumnus is assured of a hearty welcome. The fraternity man leaving his college to go to another in which his organization is represented will find a group of friends ready to receive him, and, if a chapter house is maintained, usually to provide him with a room and a place to eat and to spend his spare time in congenial surroundings.

From the standpoint of student, instructor, and alumnus, a national fraternity is to be preferred to a local. However, national fraternities of high standing are not willing to consider applications for charters from any but well-established local societies which uphold as high a standard of membership as do the nationals themselves. Consequently, if it is desired to establish a chapter of a national fraternity, the first step is to build up a strong local organization, with high standards of membership, and then to apply to the national society which has been selected.

There are several national chemical fraternities of both types in successful existence, but information is only available on two, one of each class, the others not being listed in the standard fraternity handbooks. Of those listed, Phi Lambda Upsilon is the older, being established in 1899. It is an honorary society, and, according to the directory of June, 1925, has 19 chapters and about 3000 members. The other, Alpha Chi Sigma, is a professional chemical fraternity, and is younger and larger. It was founded in 1902, and now has 38 chapters and over 5000 members. These organizations include in their chapter lists most of the larger colleges and universities.

The other chemical fraternities have only come to the writer's attention through occasional news items, but no definite information regarding any of them is available. They all appear to be primarily small college

organizations, if one may judge by the occasional brief notes appearing in the chemical press regarding them. It is to be hoped that the officials of these societies will see to it that notices are placed in the newer editions of the fraternity manuals, as there is a real demand for chapters of chemical fraternities, honorary especially, in the smaller colleges, particularly those unable to maintain chapters of sufficient size to meet the requirements of the larger organizations.

Says Ether Drift Experiments Not Fatal to Einstein Theory. That Einstein's theory of relativity is not overthrown by the experiments performed by Dr. Dayton C. Miller, professor of physics at the Case School of Applied Science, Cleveland, and described by him before the recent meeting of the American Association for the Advancement of Science at Kansas City, is the opinion of Dr. Ludwik Silberstein, mathematical physicist of the research laboratory of the Eastman Kodak Company. Dr. Silberstein has studied Einstein's theory for years and has written an important treatise on it.

Professor Miller's experiments seem to show that the earth is drifting through the ether which is supposed to pervade all space and through which light and similar waves are supposed to be transmitted, and the amount of the drift is greater on a mountain top than at sea level where it is very slight. It was on the assumption that such an ether drift did not exist that Einstein's first work was largely based. However, other experiments have verified the predictions of Einstein, and while further verification of Professor Miller's experiments may lead to a considerable revision of the first or "special" theory of relativity, proposed in 1905, many of the fundamental aspects of the later or general theory of 1915 will remain unchanged, says Dr. Silberstein.—*Science Service*

New Dye Will Aid Astronomers. "Neocyanin," a new dye recently developed in the research laboratory of the Eastman Kodak Company, may prove valuable to astronomers in photographing heavenly bodies by the long invisible infra-red rays, says Dr. C. E. K. Mees, director of the laboratory. The ordinary photographic plate is sensitive only to blue light and the shorter and invisible ultra-violet rays, but by bathing the plate with certain dyes before exposure, they become sensitive to light of approximately the same color as the dye used. Ortho-chromatic plates and films are thus treated and become sensitive to yellow light, but the new dye makes them sensitive to light waves as long as one twenty-two-thousandth of an inch, while the longest rays visible to the eye are about one thirty-thousandth of an inch in length.

Plates bathed with the new dye are expected to prove especially useful in spectroscopy, for photographs made through the spectroscope show many light and dark lines which to the astronomer reveal the star's pedigree and character. Many of these lines occur in the invisible infra-red region of the spectrum and photographs made by the new plates will help give a more accurate idea of the star's nature. Modern astronomers use the photographic plate almost exclusively, instead of observing the heavenly bodies directly through their telescopes.—*Science Service*

To Study Science of Pacific Region. After a year of preliminary work, the Pan-Pacific Research Institution has been formally organized by its president, Dr. David Starr Jordan, in order to bring about closer relationship between all groups of research workers about the Pacific. It will carry on such work on its own account and, for the present, will consider, primarily, the problems of food, health, and population.—*Science Service*

THE TOWN AND THE CHEMIST

C. C. KIPLINGER, ALLIANCE, OHIO

Frequently the chemist in the small city or town finds himself called upon to pass judgment on chemical problems arising out of the civic activities of his community. Approximately five years ago a knock on the front door aroused me from a reverie concerning the orbits and gyrations of electrons and protons dispersed throughout a sea of intangible and hypothetical ether. In a mood similar to that of Kekulé, when formulating his benzene ring concept, I answered the summons and, on opening the door, perceived a pompous individual who introduced himself as the safety director of our little city.

Possibly because he had no search warrant, he courteously declined my somewhat reluctant invitation to step into the parlor, moved his basket into the foreground, causing a musical tinkling of glass therein, and sweeping a newspaper covering from its top, revealed to my wondering vision nine small bottles, each containing a few cubic centimeters of a colored liquid.

"These are mouth samples of liquor," he explained, "obtained by detectives who, having bought drinks in various 'soft drink' places, retained the liquid in their mouths and stepping out, emptied the liquor into these small bottles which they always carry with them. Can you analyze these?"

I looked askance at these literal offerings from the mouths of men and marveled at the fortitude displayed in refusing to permit a single swallow to destroy the evidence. These samples ranged from eight to twenty cubic centimeters, seeming to indicate a remarkable variation in mouth capacity, or an occasional leaky throat. Carrying as I was at this time the burdens of the chemical department of a small and well founded, but not so well funded, college, the problem of handling the city's liquor work meant an addition to my labors of no mean magnitude. However, this extra responsibility was accepted cheerfully on the grounds of the civic duty which every chemist owes to his community.

At this point I would raise a question. I have never been sure in my own mind that the teaching chemist is justified in taking on any large amount of outside chemical work. Where such has been done, I have observed that the teaching ultimately suffers. The youth of today need the help, coöperation, sympathy, and philosophy of the teacher, these essential elements being given best by frequent private conferences, the latter requiring all the spare time and strength that the average man or woman can command. However, this is a moot question and one that is worthy of further discussion in these columns.

Owing to the lack of a dipping refractometer, the following method was used for determining the alcoholic content in these small samples.

It will be recognized as a small edition of the official method and by noting the additional precautions, good checks can be had. Much less time is required for the new procedure and the equipment can be found in the average high-school laboratory.

Two 25 cc. pycnometers of similar make—ordinary specific gravity bottles—were selected from stock. A glass cap was blown for one so that the flange of the cap rested on the bottle proper, thus entirely covering the neck and stopper. This cap served to retard evaporation and to increase the weight of the pycnometer. It can be made by cutting a sufficient length from the bottom of a small test tube and flaring the mouth of the cap thus formed for the flange. It need not fit the bottle accurately. This pycnometer and cap were counterbalanced with the second pycnometer, adding sand and bits of paper until almost balanced, then sealing the stopper and capillary with paraffin and adding or removing the wax until the correct weight was attained. The counterbalance should always be used in weighing the liquor pycnometer. The latter was calibrated in the usual way. The weights also were calibrated by Richard's method. These precautions are absolutely essential for good results.

Approximately 8–10 cc. of the liquor were poured into the pycnometer and weighed with the greatest possible accuracy. This was then emptied into a 50 cc. distilling flask, rinsing the pycnometer with 15–20 cc. of distilled water into the same flask. A pinch of precipitated chalk was added and, in the case of wines and beers, also a small pinch of tannic acid. The delivery tube of the flask having previously been bent so that the delivery end pointed downward when the flask was vertical, the latter was attached to a small vertical Liebig coil condenser, *a la mode* for distillations of this type. From 15–20 cc. of distillate were collected in the same pycnometer, distilling slowly. Distilled water was then added, avoiding mixing as far as possible, until it was judged that the insertion of the stopper would fill the pycnometer with a minimum overflow of liquid through the capillary. The stopper was put in place, but the overflow was not removed from its top.

The pycnometer and contents were placed in a shallow water-bath and brought to the desired temperature, this taking about twenty minutes. Removing the bottle from its bath, it was placed on the table and a 100-gram weight suspended by a stout thread slowly lowered until it rested on the stopper. The first insertion of the stopper having been made with a gentle force, this latter step insures the stopper penetrating the same distance into the bottle in each experiment. Owing to slight departures from the cylindrical of both neck and stopper, it is wise to make vertical marks on these and to bring the marks into coincidence on succeeding trials. Only by observing precautions of this type can ordinary

specific gravity bottles be made to give consistent volume readings. The excess liquid was rapidly removed from the stopper and sides of the pycnometer, the cap put in place, and the pycnometer and contents weighed rapidly and accurately.

The weight of the alcohol, W, was determined from the specific gravity tables. $W/W_1 \times 100 = \%$ Alcohol (by weight), where W_1 is the weight of the liquor sample.

Having completed the liquor analysis, it is only a step from the laboratory to the court-room where the chemist is called on to "tell the whole truth and nothing but the truth as you would answer unto God." Keeping this in mind, one of the first questions put to him by the State's Attorney is, "Do you consider this liquor fit for beverage purposes?" In spite of an experience covering hundreds of cases, I never entirely overcame some inner misgivings when answering this question.

One legal light, seemingly a member of the "Bootlegger's Protective Union," asked a witness for the State, "What is alcohol?" The witness replied by giving the formula, which sufficed to satisfy the attorney's curiosity, he evidently having failed to include chemistry in his educational equipment.

The social service rendered in this type of work has yielded experiences and contacts that will never be forgotten and there remains a certain and perhaps excusable pride in having been at the front in one of the greatest moral crusades of our day.

Various other calls have come to us from time to time. Only recently, a white-haired farmer and his good wife drove a distance of several miles in an old-fashioned buggy, kept from sharing the fate of the "One Horse Shay" by sundry bits of wire and binder twine, bringing a quart of dirty looking water in an equally dirty fruit jar, for my inspection. My answer to his inquiry as to the cost of such an analysis elicited the following remark; "Good land! My neighbors have worn out my pump using this water and I can't afford to get a new one as it is. But I have been having so much 'stummick' trouble." In view of our mutual limitations, we finally agreed that the best solution of his problem was to boil the water and to warn the neighbors to do likewise.

Although we have a city chemist who takes care of the municipal water and sewage problems, there are many requests for the examination of well and cistern water and these come chiefly from folks who have no knowledge of the work required for the solution of their problems; consequently they are unable to comprehend the financial expense entailed. Much tact and diplomacy are frequently demanded to avoid hurting the feelings of our good neighbors.

Food analyses, poison cases, soils and fertilizers, stucco and cements, and medical work are items that have fallen within our experience. The

eternal rivalry between butter and "oleo" is a source of some work. All in all, the contacts of the chemist become very numerous and intimate in so far as the life of his community is concerned, and he can become a factor of ever-increasing importance, if he so desires.

However, certain pitfalls must be pointed out. The idea of service to the community must be held paramount. If he be a teacher, in serving his community he is serving his institution, and herein lies the justification of such outside work. The idea of financial gain must be kept in the background as relatively unworthy. Also, the teaching chemist must not expend so much of his energy on this sort of thing that he neglects his students, who look to him for guidance in all matters of the mind and spirit. If he does, he is forgetting the purpose for which his institution was established, neutralizing his physical and mental effectiveness, and, last but not least, failing to gain the affection and respect of those committed to his care, thus losing the most precious reward that comes to the laborer in the field of education. Honest conscientious service to all will be the motivating force in the activities of all worthy followers of Liebig.

Color Movies Coming into Vogue. Black and white motion pictures, now so popular, may soon be superseded almost completely by films taken and produced throughout in natural colors, judging by the activity of several producing companies.

Slapstick comedies will doubtless continue to appear in drab monochrome for some time, but in feature photography the large conservative Hollywood producers are now capitulating to the demand for color. At least a part of several major screen dramas now in preparation will revel in chromatic glory.

With the aid of super-illumination much in excess of the usual studio requirement, the photographer now takes two films of the same scene simultaneously through a single lens. One of these responds only to green light, and is finished as a green transparency. The second, recording only red, is finished in red. The two films, pasted back to back in exact register, are ready for the exhibitor. There is no photographic deposit of metallic silver as in the case of the ordinary black and white picture.

Artists, accustomed to a whole galaxy of pigments, can hardly believe that red and green alone can yield such accuracy and variety in shade. Sky tints; anything you wish in leaf, tree-trunk, or earth shades; every possible hair and flesh tint, and even the regal effects of warm black plush and golden satin are faithfully and beautifully recorded. Pure lemon yellow, cobalt blue, and the pure purple shades are not available, however—at least not until some three-color process is perfected. Unfortunately, there are only two sides of a film, so that the third color doesn't know where to go. These shortcomings, nevertheless, are not noticed by the cinema patron, who spends most of his time appraising the flesh tints anyway!

The color film costs several times the figure for black and white. However, when even the cheapest comedies cost five dollars per second of theater exhibition time, or in other words five dollars per foot of film, the added expense does not rate high when compared to other costs. Unlike the hand-tinted films of previous years, the new films may be duplicated, in positive, indefinitely without continued repetition of the great initial cost.—*Science Service*

BROADENING AGRICULTURAL CHEMISTRY

WM. P. HEADDEN, COLORADO AGRICULTURAL EXPERIMENT STATION, FT. COLLINS, COLO.

There are many things pertaining to general chemistry which are not yet satisfactorily worked out but the explanations at the student's command today are much more adequate than those of some years ago. The teaching of this branch of chemistry is comparatively simple compared with its application to agriculture. The facts of general chemistry are definite and universally applicable to what we may designate pure chemistry but the matter is by no means so simple when questions of climate, life, and association become involved and even the geological histories of the lands have a significance.

The pioneers in agricultural chemistry dealt very largely with conditions in humid countries with soils already exhausted by long cropping and whose basic mineralogical constituents were poor in potential food elements and non-reactive. The teachings of agricultural chemistry have grown up on this foundation and teachers have imbibed these doctrines and pass them on to their classes.

We believe with such remarkable tenacity the things that we have been taught early in our experience that it becomes almost impossible for us to conceive of conditions totally different from those which we have learned about or which have come under our observation. The facts known to us are the ones that we can apply and they, unfortunately, appear to us to be always and everywhere applicable. We easily become dogmatic and when a misgiving presents itself, we bluff. Tolerance for other views than those laid down in the reliable authorities might be a virtue but it should not be practiced; it might lead to confusion or worse. So we follow in the ways of our predecessors because it is easier and receives general approval. This attitude on the part of the teacher is, within reasonable bounds, highly commendable and in some cases there is no choice of facts to be presented and but little or no choice in the interpretation of them.

In teaching agricultural chemistry the path is not so easy even when the student has a good preparation, for the correctness of his teaching is contingent upon many facts which are only partially known or perhaps totally unknown to him. They are factors he cannot evaluate because they don't appear in his statement of the problem. If he attempts to apply his chemistry to agricultural problems, he finds that he is involved in questions of plant physiology or biochemistry that he cannot solve and he will probably seek in vain for any satisfactory explanation.

It is universally true that green plants need nitrogen, phosphorus, potash, water, carbon, light, etc., to effect their growth and reproduction and the most of them need a soil in which to grow. This soil may vary

greatly and the light—sunlight, of course—may also vary in its properties and effects.

We will dismiss the light question with few words for the very cogent reason that we know little about it. We will take an inanimate object to emphasize the force of the statement that the sunlight varies in its properties. The sunlight in Colorade, Nevada, and California will excite a strong luminescence in certain minerals. The sunlight in New York state has always failed to do this even when the identical mineral was transported from one state to the other. Altitude and the amount of moisture in the atmosphere were suggested causes that lay near at hand but when the tests were made at Berkeley, California, with perfect success we eliminated the question of altitude and put a big interrogation point after the suggestion of moisture as the cause.

In Colorado sunshine may—sometimes does—injure some staple crops; perhaps it does in the eastern states also but if so I have not seen the fact mentioned. Our inference is that light aside from temperature is a variable, as well as an important factor, not in the general sense that it is indispensable to the development of green plants but in a specific sense, that the composition of light itself is variable and may at times or in some localities have different effects upon them, sometimes injurious to the extent of killing them. This is true of well-established plants growing in the open and does not refer simply to the sunburning of transplanted house-plants. The effect can be imitated by artificial means but whether identical results are produced or not I do not know. This is clearly within the domain of the plant physiologist.

The questions of the soil and plant nutrition are better known to be complex. The sunshine proceeds from a common source and while mixed in its nature is usually considered as sunshine and its absence as shade. We recognize in a general way that soils vary in a number of respects but the facts emphasized in our text-books and class-rooms are those of humid climates and of exhausted soils, while those pertaining to arid or semi-arid climates and virgin soils, which are different in essentially every respect, are either wholly ignored or inadequately discussed. The agriculture of these semi-arid or arid countries presents new problems which do not harmonize with those of the humid countries. These new facts are gradually making room for themselves and should continue to do so in an increased degree.

The soils of these semi-arid countries are different from those of the humid ones—to which patent fact a number of conditions contribute. Even when originally derived from the disintegration of rocks of the same character they are very different. The lack of moisture has made the disintegration slower and its products have not been leached out. This is illustrated in almost every railroad cut in the west and by every boulder

of igneous rock scattered on our mesas. The railroad or perhaps highway cut will show a white stratum usually parallel with the surface. This is a stratum of marl (calcic carbonate). If a boulder on the mesa be turned over, its under side is found to be encrusted, principally with calcic carbonate. This comes from the decomposition of the minerals in the soil or the boulder by carbonated water but there has not been enough water to carry the difficultly soluble carbonates beyond the line of deposition. Sometimes this marl contains some sulfate. The other products of decomposition have not been transported very far. A goodly proportion of them is still present and our soils may carry large percentages of water-soluble matter.

The major part of our alkali questions arises from this source. It is common knowledge that an irrigated country is apt to be troubled with alkali patches. This is an evident result of the removal of the water-soluble alkali from the soil. A humid country may need drainage to remove water but not to remove alkalies, as the newly irrigated one may.

The effects of these soluble salts on the production of crops or on the properties of the crops produced are questions not discussed except here and there in a station bulletin. This question arose in our work preparatory to the establishment of the sugar-beet industry in Colorado. The results of our study of this factor upon the ash and sugar content of the beet were not in keeping with our expectations.[1] We expected to find the percentage of ash very high and rich in soda salts. We found the percentage of ash, reckoned on the dry matter, in beets grown in strongly alkali soil increased by about two per cent. In other works the effect of a very large amount of alkali was to increase the ash over that present in check beets grown on the college farm by two pounds per hundredweight of ash.

When it came to the composition of the ash we were again disappointed. The reader in any measure acquainted with the beet plant will feel that we were justified in expecting to find these ashes richer in soda and poorer in potash than those grown on good soil. This was reversed. The ash of the check beets carried more soda than the experimental ones. The soluble salts in the soil so-called alkalies had no effect on the sugar content.

We recognized in this alkali soil a plentiful supply of nitrates but it was several years subsequent to the completion of our report on this work that the nitre question seriously engaged our attention. This was an open field at that time although Prof. Hilgrad had previously noticed this association in California.

Neither the alkali nor the nitrate has to any extent constituted a recognized factor in the agriculture of the eastern states or in Europe proper, so mention of them is as good as wanting. The nitre question became,

[1] *Bulletins* **46** and **58,** Colo. Expt. Sta.

it is true, a question of scientific interest in the '80's and '90's of the last century. Neither, however, was practically recognized until late in the first decade of this century. The facts that forced attention to them were unexpected and serious ones, to wit, the extremely violent results of their presence in excessive quantities, as evidenced in the killing of apple and other orchard trees on a large scale. The progress of these effects was rapid and orchard after orchard succumbed. The development of nitrates in cultivated land on such a scale was unheard of. It had been previously shown that ordinary cultivated soil possessed the power of fixing nitrogen and also of nitrifying it. These facts were not new, but the extent to which these processes may be carried in our alkaline soils under our climatic conditions was, and is yet, inadequately appreciated. The extent of this production of nitrates in our soils, their effects upon orchard trees, and the proof that the nitrates are the cause of these are presented in the bulletins of this station[2] which are now out of print. We found, however, amounts varying from a few tenths of a per cent up to more than thirteen per cent of the surface soil. The distribution of the nitrates as well as of other soluble salts become important, as well as interesting questions but can scarcely be given detailed consideration in a paper of this scope.

It requires neither any great familiarity with, nor interest in agricultural chemistry, nor yet any extended experience in field practices to understand that if these extreme instances indicate a general condition, these violent effects are the exceptional ones and it becomes an important matter to learn what are the less violent ones. The problems hereafter discussed throw some light on the subject. They are treated in the order in which they presented themselves. We did not have to seek out these questions but field facts forced themselves upon us for explanation.

The Beet Crop

We have already alluded incidentally to the activity of this station in the establishment of the sugar-beet industry in this state. The efforts of the station were exerted in this direction for at least ten years and we were familiar with the crop, its yield and quality.

In the Arkansas Valley the beets averaged 17.5 per cent sugar from 1893 to 1900. A factory was erected at Rockyford and the beets worked from 1900 to 1904 or 1905 averaged about 17.5 per cent sugar. The beet since that time has been somewhat improved in its sugar content but beginning about 1905 and continuing, with some fluctuations in the rate, the sugar content fell to an average below 14 per cent. The cause of this was sought out and demonstrated to be the excessive development of nitrates.[3]

[2] *Bulletins* **155, 178,** and **186.**

[3] *Bulletin* **183.**

The effects expressed themselves in an excessive growth of top, a beet of objectionable shape, slow in maturing, low in sugar, and producing too much molasses when worked for sugar. No study in which the writer has ever engaged showed more plainly and conclusively the radical divergence between the facts of our agricultural practices and the dicta to which we were accustomed to give our respectful adherence. The account of this work is recorded in another bulletin of this station entitled, "The Deterioration in the Quality of Sugar Beets Due to Nitrates Formed in the Soil." The conclusions of this bulletin are based on a very extensive series of data.

I cannot refrain from quoting the almost despairing statement of the beet company's agriculturist. "The more nearly we approach to the ideal agricultural conditions and practices, the more disappointing are our results," and he had good cause for the statement. Some may think, and I venture that many who read these statements actually think that they could have solved this man's problems, but we think otherwise. This man was one of broad experience and thorough education; furthermore, he had had eight or ten years' contact with the conditions in that locality. He did his best and it would require many papers to recite the variety of his endeavors to meet the situation and to give their results. The outcome of it all has been given in the remark quoted.

Other explanations for this falling off in the quality of the beets have been offered. There may be some merit in every suggestion made but the one big, adequate, and sufficient cause is the nitrates, whose presence can be demonstrated in the soil and the beets and, of course, in all of the factory products and in the Steffens' waste water. Michigan beets yield approximately 5.5 per cent molasses. Some of the beets worked on a factory scale in the Arkansas Valley have yielded 9.5 per cent. Some of our experimental beets yielded a thick juice of 69 purity which is scarcely better than molasses.

The reader may wonder how much nitrate may be developed in the lands of this valley. The maximum that I found in a very bad piece of land, planted in beets was at the rate of 9 tons per acre in the upper three inches of soil.

We have to do with the question of balance between the respective elements of plant food, and fertilization was tried in an endeavor to adjust this and find out how the matter stood. The experience was highly interesting but disappointing in that we did not obtain the expected results. We pass over this important phase of the question with the simple statement that farmyard manure was the only fertilizer that we found profitable and that green manuring was the best corrective for the nitre trouble and this was effective to the extent that it increased the sugar content from 11 per cent in beets from a check plot to 16.5 per cent in those from the experimental plot.

The preceding statements might lead the reader to infer that beets grown in the valley were uniformly poor. This was not the case. There were some excellent beets grown each year but the average was low. This variation in the quality of the crop presented its lessons, which were evidently to the effect that we were to seek the cause in the variations in soil conditions.

What has been said demonstrates the peculiar questions presented by this crop in the Arkansas Valley, but none of these things are applicable to the northern portion of this state, where the average sugar content of the crop is not so high as it was in the Arkansas Valley from 1900 to 1905, but has remained wonderfully constant for twenty-odd years.

The Wheat Crop

Fifty years ago the fields of wheat reported from this state were considered phenomenal; fifty bushels and upward per acre were obtained from the then virgin soil where water could be obtained for irrigation. The properties of this wheat were variously esteemed from most excellent to inferior. Later there came to be a definite opinion that its quality was such as to produce a good biscuit and pastry flour but not a good bread-making flour. It was even asserted that hard seed wheat imported into this state produced soft wheat, often the first year, but surely in succeeding years.

No subject that might possibly be chosen could better present the need of extreme caution in offering explanations for observed facts or for hesitancy in accepting explanations upon authority, than this one.

In one form or another the conditions and causes for the softening of wheat have been discussed very often. I know only fragments of this discussion. The consensus of opinion has been that climate, almost to the exclusion of all other factors, determined the quality of wheat. One must confess that the case seemed to be well established—based on many observations. So firmly, indeed, is this view intrenched, that we find such statements as this: "The soil, it is true, is one of the most potent factors in determining the size of the crop and the amount of material harvested, but it does not have a very marked influence on the chemical composition of the crop produced."[4] On the other hand there are many statements to the effect that the soil, cultivation, and manuring very greatly affect the chemical composition of wheat but opposed to this it is stated that the soil has the least effect of the factors of environment upon its chemical composition: climate, also expressed as weather conditions, is claimed to be the controlling factor. By weather conditions is meant the temperature, sunshine, and rainfall.

So far as Colorado is concerned our temperature and sunshine is more

[4] "Year Book of the Department of Agr.," 1901, p. 303.

than abundant and our rainfall is insufficient to assure us the normal maturation of a crop and yet our wheat is so soft that it yields a biscuit or pastry flour and not a good bread-making one. The character of our climate and the necessity of irrigating to mature crops are universally known, but there was a question as to its being a fact that our wheat yielded a poor bread-making flour. A generally accepted opinion deserves some investigation before it is rejected. The practices of the baking industry constitute the best criteria on which to judge of the soundness of this view concerning our flour. On inquiry I found it to be a fact that the bakers very generally used Kansas or Minnesota flour for bread-making and asserted that these flours made from 30 to 40 loaves more bread per barrel than our Colorado flour. It further developed that our flour was marketed largely in the south for biscuit making and elsewhere as a pastry flour to good advantage.

Our climate is noted for the very conditions which are supposed to produce hard wheat and yet our wheat is soft to the extent that our flour is a biscuit and not a bread-making flour. This discrepancy between the teachings on the subject and the facts threw serious doubt upon the correctness of the teaching. Two things seemed evident, first, that the teaching was not wholly correct, and second, that the application given to it was too broad and unconditional. Our practice of irrigation was a convenient means of trying to bridge this difficulty since it has been claimed by writers that this practice softens the wheat.

A great mass of details on this general subject has accumulated during the past. The problem for us was clear. We have an excellent climate with sufficiently high temperatures, and almost continuous sunshine, so there is no lack of energy due to the insufficiency of these factors, and the rainfall is not sufficient to supply the necessary moisture for the growth of the plant and irrigation is necessary. The assumption that water applied as irrigating water and water falling on the plants as rain or heavy dews have the same effect upon the crop, seems to be generally accepted; at least, has gone unchallenged as far as I know.

The wheat of England, Scotland, Sweden, France, Holland, Denmark, all countries of coastal climates, equivalent to countries with heavy rainfall, is soft wheat. The kernels are plump and big and weigh from 38 to 45 grams per 1000. The grains of southeastern Europe from countries of less rainfall are harder wheats and weigh from 16 to 34 grams per 1000. This correlation between rainfall and the size and character of the kernels is generally and rightly accepted and justifies the importance attached to weather conditions. The weight of 1000 kernels of our experimental wheat reached a maximum of 46.82 grams and fell to a minimum of 16.17 grams. These crops had received the same total amount of water (about 18 inches) during their growing period. The 1000 grains that weighed

46.82 grams were grown during a very favorable season and those weighing 16.17 grams during an unfavorable season and tend strongly to show the correctness of the assertion that weather is, in fact, an important factor. There are, however, other phases to the factors that caused these differences.

I think that it may be doubted whether the suppression of temperature and modified light, modified in both intensity and quality, would have been sufficient to account for the differences indicated by the difference in the weights of 1000 kernels. There were other radical differences in the crops, but we desire to give only general facts sufficient to make plain the care with which the apparently best established facts for one set of conditions are extended and applied under other conditions.

I have stated that these two crops were grown with the same amount of water (18 inches). Our experiments were made with spring wheats whose growing period was about 120 days. The water received during the favorable season was: from irrigation, 12 inches; and from rainfall, 6.8 inches, 2.5 inches of which fell between the 13th and 24th of July and was followed by a period of bright, warm weather. In the other season with lighter weight per 1000 the rainfall amounted to 12 inches and that added in irrigating was 6 inches. The temperature during the two seasons was very nearly the same. The mean for the better season was 60.1°F. and for the other season 59.5°F. During the good year we had only four cloudy days, during the second year we had only 57 days designated as "clear." In other words more than one-half the days were stormy.

We followed the composition of the plants throughout each of these seasons. During the cloudy season it was difficult to get samples of plants dry enough to work with, and the samples examined differed widely in composition from those of the normal season. Rust attacked the wheat plants but the composition of the plant had been radically changed before this happened. All this supports the view that weather conditions are very important. It fails to prove that moisture, *per se*, is the cause of mealiness or that irrigation will produce identical or even similar results, both of which have been maintained. We have grown wheat with the addition of two feet of water in two applications, so that the ground was constantly wet. The results were of an entirely different character; in fact, the excessive application of water to the soil was practically without effect upon the composition of the wheat. Its application, of course, was accompanied by the risk of ruining our crop through exposing it to the danger of being blown down and of being rusted. In a series of experiments placed at my disposal, I found the highest protein content in a sample grown with 0.71 foot of water and the next highest in one grown with the application of 3.28 feet. These were samples of an exceedingly soft wheat, and while the results indicate that irrigation does not depress

the total nitrogen, they do not in any more direct way prove that it is no factor in the softening of wheat. We have, however, experimented with hard spring wheats that prove this inference to be a correct one. In these series we used Kubanka and Red Fife and Marquis; the first a durum and the others hard varieties. A soft wheat, Defiance, was also tested. In no case did excessive irrigation produce or increase mealiness or yellow-berry in the crops. Rainfall is, therefore, plainly blameable for poor quality.

Lawes and Gilbert offer the explanation that rain washes out of the soil the nitrates on which the nitrogen or protein content of the grain depends. This explanation does not apply to our case, for three feet of water applied to the soil within a period of about 120 days, the total lifetime of the crop, is without effect and it is enough to produce leaching.

The thirteen inches of rainfall during our bad season probably effected no leaching at all and, at most, it could not leach as much as the larger amounts used in irrigating during the other seasons, but the effects were very bad. The rainfall and dews are applied to the plants and leach them, a fact easily demonstrated. The irrigating water is applied to the soil, and that which is in excess of the needs of the plant is as good as without effect except that the excessive softening of the soil exposes the grain to the danger of being blown or beaten down during heavy showers if such occur.

Fertilizers are claimed to increase the nitrogen content of wheat and it is tacitly assumed and sometimes explicitly stated that nitrogen increases the flintiness or hardness of the grain. This depends upon the nature of the fertilizer. Phosphoric acid and potash do not increase the percentage of nitrogen in the grain. Farm-yard manure, unless well rotted, acts rather as a potash manure than a nitrogenous one. It increases the dry matter produced but does not beneficially affect the composition of the grain. On the other hand the application of nitrates produced in every instance flinty kernels which, however, were small and often shrunken.

The weight per 1000 grains has been given as indicative of the difference between wheats grown in the coastal countries and those in the southeastern parts of Europe. The range of this weight for our experimental wheats is from 16.17 to 46.82 grams. Our whole experimental plot was less than eight acres in one continuous area yet this range is wider than that given for the whole of Europe which is from 16–45 grams.

Two reasons are assigned for this difference in the case of European wheats—the climate and the different contents of soluble salts in the soils—neither of these apply in our case. The climate and the land are both the same but the weights per 1000 grains from differently treated plots vary more than they do in wheats grown in the coastal countries

of Europe and southern Russia. The ranges given include all varieties, some small-grained and others large-grained. While it might be more satisfactory if we could compare the effects of these factors, climate, soil, and culture, upon the same varieties in different countries, our purpose is to consider how far general features may be safe guides. It is in this way that these facts have heretofore been assumed to apply.

In our experiments we have the whole range of European and American experience on a small and easily comprehended scale. We eliminate climate and the question of the influence of soluble salts, for we obtain just as wide a range in the weight of 1000 grains with three varieties of wheat on an area of eight acres or less as is given for the whole of Europe.

The following holds good for each of the varieties. The weight varies slightly with the section of land on which the wheat is grown. The weight of check wheat and that grown with application of phosphorus are always very close together; potassium uniformly increases the weight and the application of nitrates decreases it. The exceptions to these statements are very few in number.

The mealiness of the kernels varies roughly with the weight: phosphorus has no effect, potassium increases it, and the nitrates practically eliminate it.

These statements are equivalent to the assertion that mealiness depends upon the ratio existing between the supply of nitrates and that of potassium. The former produces small, often shrunken kernels, the latter large, plump, mealy ones, while phosphorus is without influence, as is also irrigation.

The interrelation between these fertilizers is decidedly interesting. The amount of nitrate available to the plant influences the intake of both phosphorus and potassium, depressing the former and often slightly enhancing the latter. These relations are discussed at length in the bulletins of this Station issued under the title of "A Study of Colorado Wheat."[5]

The opinion that dry-land wheat is hard wheat is quite general but there is no good basis for this. It seems to be the result of an impression that moisture is the cause of the softness of wheat which is not the case. Dry-land wheat grown after wheat may be very badly affected by yellowberry; *i. e.*, be soft wheat. The explanation of this is that the wheat plant not only uses up the nitrates available, but suppresses in a marked degree their formation.

I venture to hope that the general outcome of this study of Colorado wheat may interest the teachers that read this, for while we attained our object; *i. e.*, to find out first whether the assertions made about the softening of hard wheats when grown in Colorado were justified, and second the cause of this if it be true, we found the actual cause to be one that we did not suspect. Although we knew that the total potash (K_2O) present in

[5] *Bulletins* **205, 217, 219, 244, and 247.**

our soils averages around 2.25 per cent or higher, I did not in the beginning suspect this of playing the part that it does. Rather I suspected all of those conditions that together permitted or induced the development of excessive nitrates in our soils to constitute the factors in the wheat problem, as we had found them to do in the beet problem. There were reasons, rather evident ones, for doubting this, so we put it to the test of experimentation with the results sketched in these paragraphs, wherein we have tried to indicate some of the problems that present themselves in our agriculture and to suggest the many points usually accepted as applying to their solution but which present difficulties or altogether fail.

The study of the wheat crop probably presents more questions than the orchards or the beet crop, and to the average person perhaps more satisfactory results, but possibly leaves the impression that they contradict one another in that nitrates killed the orchard trees and lowered the quality of the beet crop, but increased the quality of the wheat, for hard wheat is superior to soft wheat. We have tried to leave the impression that by increasing the nitrogen in the wheat the tendency is to improve this quality, while an excessive supply of potassium tends to soften the wheat. I understand the market makes a discrimination of from one to five cents per hundredweight against yellow-berried or soft wheat.

There are other facts which should not be omitted. While too much potassium softens the wheat, too much nitrate may utterly ruin it. The kernels are small and hard, but often shrunken, even when there is no other cause for the shrinkage. These are the characteristics of wheat grown with too much nitrates. In the experiments conducted, two hundred and fifty pounds per acre was so much too much that the yield was depressed in eleven out of twelve cases.

The fixation of nitrogen by ordinary soils in countries of heavy rainfall may never be a dangerous factor, but it is a very dangerous one in Colorado. The most striking and perhaps as important as any is its development in orchards kept in clean cultivation. We have found nitrates, calculated as sodium nitrate, equal to many tons per acre in such orchards and also in beet lands.

Closely connected with this are the questions of rotation in ordinary crops, and of cover crops in orchards. I am sure that many persons will not understand how much I mean by the former portion of this last sentence. Therefore, an illustration to explain: a piece of land, within a single inclosing fence, was divided into two portions—one portion was planted to beets and potatoes for three successive years, the other portion was seeded to alfalfa which stood for two years. The whole field was planted to potatoes the ensuing year. In the portion that had been in potatoes the three preceding years, we found the equivalent of 4692 pounds of sodium nitrate in the top six inches of soil per acre; in that which had

been in alfalfa, 324 pounds per acre. Where potatoes followed potatoes there was no crop, but after the alfalfa there was a very heavy crop of vines and 140 sacks (about 15,500 pounds) of potatoes. The alfalfa had suppressed, and the cultivation of potatoes had favored the formation of nitrates, together making a difference of $2^1/_4$ tons of nitrates per acre, and in the crop, the difference between success and total failure.

Summary

. General principles of agriculture based largely upon results under humid conditions need material modification when applied to other conditions. The tacit assumption that irrigation and rainfall produce the same effects upon the wheat crops is wholly wrong.

We have the record of the effects of applying three feet of water within 120 days to this crop. These effects were a slight increase in the dry matter produced but the composition of the grain was in no way affected. On the other hand, thirteen inches of rain falling in sixty-three cloudy or stormy days out of 120 changed the composition of the plants in every detail, and the nitrates available to the plants were as abundant as in our most favorable year.

Cocaine and Borax in New Anesthetic. Tests on a cat's nose proved the efficacy of a new class of local anesthetics developed, from cocaine, by Dr. A. J. Copeland of the British Medical Association and Dr. H. E. F. Notton of Cambridge University. The group of substances are called "borocaines" because they are combinations of boric acid and cocaine.

On the nose of a cat, borocaine caused congestion of the erectile tissue and obstructed the flow, but the nerves controlling the blood vessels were not paralyzed. When adrenalin is given in conjunction with ethocaine borate, one of these "borocaines," it causes all the anesthesia desired and yet does not make the tissues shrink and hinder operations.

Anesthetics made from cocaine are produced by combining the cocaine "base" with an acid to make a salt. The salt is the anesthetic. The kind of acid used gives the substance its character. When a weak acid is used, the salt formed undergoes chemical disintegration only weakly, and permeates the neighboring tissues and the general circulation very slowly. Most of its anesthetic action is therefore saved for the place where it is applied.

When a strong acid is used, the opposite is true. The salt formed has the power to dissociate very rapidly, and the substance soon spreads itself over the entire system. It is then only weakly anesthetic where it is applied, and poisonous to the system into which it spreads.

To make "borocaines," boric acid, a notably weak acid, is used, and it is from this that the name is derived. Borocaine is a surface anesthetic, and the efficiency depends on keeping the salt alkaline at all times. Its value is in its special affinity for the nerve fibrils where it is applied.—*Science Service*

Correspondence

ADVANCED COURSES IN HIGH-SCHOOL CHEMISTRY

In the hope that they may be of interest to our readers, we publish the following three letters, which are self-explanatory.

I have a question that you may be able to help me with in some way.

Last year I had about 25 Superior students in my beginning class in chemistry and this year they are asking that I teach an advanced class so they might have more of the subject.

We do not have any advanced class now in a school of eleven hundred students.

Do any of the large schools have an advanced class and if so what do they teach in it and have they had success?

My students want some work in organic chemistry and analysis as well as reports on recent developments.

It may be advisable to have a discussion through your paper.

Thanking you for any help you may be able to give me, I am

Very truly yours,

CENTRAL HIGH SCHOOL,
SUPERIOR, WIS.

WALTER S. TAYLOR

I am interested in your inquiry and the letter of Prof. Taylor of Central High School, Superior, Wis. I will try to outline what we do in Chemistry 2, saying in advance that the prime objective is a review of Chemistry 1 with a different mode of approach.

We use qualitative analysis for the early part of the year, but not for the sake of teaching analysis so much as making a review of the properties of the metals. For example, the class studies the metallurgy and properties and uses of silver, then runs through its qualitative reactions and recites on the whole. After sufficient metals have been reviewed the teacher presents a method of systematic analysis demonstrating this experimentally before the class. The pupil then analyzes some simple solutions ("unknowns") and a few easy, dry substances. In this fashion each qualitative group is handled. The pupil is graded on his recitations, on the accuracy of his determinations, on the quantity of these, and on his examinations. This plan makes some home study necessary even in a course in analysis.

This part of the course ends on April 1st, after which date a new sort of work is begun. Each pupil is assigned some substance for study and preparation, a different assignment to each boy: he reads up the literature on his substance, writes a theme, reads this before the class with illustrations, and sometimes with lantern slides. Then he goes into the laboratory and makes a considerable quantity of this substance, keeping track of his costs, purity of materials and of product, and the like. Then he reports to the class a second time, showing his product, discussing its purity, cost, yield, etc., and answering questions. He compares his cost with current market prices and shows his loss or profit as the case may be. These assignments include both organic and inorganic substances and when finished are turned into laboratory stock.

We have about 2000 pupils in this school, all boys: 315 are taking Chemistry 1 this year and 42 are taking Chemistry 2. A boy may start Chemistry 1 in either third or fourth year, so if he wants to take two years of chemistry he must foresee this in time to start his Chemistry 1 in third year. Pupils in the scientific course are required to do this, their elections being in some other department.

Very truly yours,

CITY COLLEGE,
BALTIMORE, MD. LESLIE H. INGHAM

We have for many years followed a one-year course of seven periods per week on general chemistry with a second-year course of 7 periods per week in the qualitative analysis of the common metals. The methods of separation throughout the entire scheme are developed inductively and applied deductively in the determination of metals in a large number of solutions, salts, and alloys.

The class-room part of this course consists of a study of principles suggested in these analyses and the commercial processes used in the production of these metals and their chief compounds.

This is followed as far as time will permit by the preparation of common inorganic substances based on Arthur A. Blanchard's "Synthetic Inorganic Chemistry."

There are two objects in this course (1) a training in careful manipulation and in logical experimentation, (2) through class-room work to broaden and deepen the student's knowledge of chemical principles, their application in the production of the metals used in this qualitative chemistry, and the uses of these metals and their chief compounds.

While this course has been successful and more students would take it were there time to do so, I am inclined to the belief that one year of chem-

istry in a high school is enough either for the student who goes to college or the one who does not, provided he takes other sciences and essential academic subjects.

MCKINLEY TECHNICAL H. S., WASHINGTON, D. C. LOUIS W. MATTERN

THE METRIC SYSTEM AND MR. DALE

Many of Mr. S. S. Dale's arguments against the metric system[1] and in criticism of my article[2] have previously been answered by Professor Bingham.[3] However, Mr. Dale's arguments do not stay answered and he has dusted them off for us again.

As historians, Mr. Dale and I seem to be greatly at variance. This is due partly to his misinterpretation of some of my statements and partly to the fact that our sources of information are different. This is often the case in historical questions where we have to depend upon opinion or authority. I did, however, point out that decimalization is the intrinsic property of the Arabic system of enumeration, and there seemed no necessity for Mr. Dale to take the trouble to convince us that the practical use of decimals must have been invented before the time of James Watt!

Fortunately the claims for the metric system are not based upon its *history* but upon its advantages for present-day *usage*. If the opponents of the metric system would agree to give metric units a fair trial by practical use, I should gladly yield to Mr. Dale on every historical point—even to the "red blood of the French Revolution." I trust he will not deny that some good may have come out of so much blood.

Mr. Dale criticizes the chart of the Metric Association which shows the advance of metric usage by countries because, on this chart, large and small countries are given equal importance. For example, the non-metric British Empire and metric Belgium are given equal values without regard to statistics of area, wealth, and population. The point intended in the chart is that each country represents a definite *decision* in favor of the metric system and that all but two countries have made this decision. It is not necessarily true that the largest and richest countries are the wisest and most progressive. The inability to distinguish between

[1] "Educating the Public in Weights and Measures," THIS JOURNAL, **2**, 1064–7 (1925).

[2] "Educating the Public in the Use of the Metric System," *Ibid.*, **2**, 593–9 (1925).

[3] "Answering Mr. Dale on the Metric System," *J. Ind. Eng. Chem., News Ed.*, Oct. 20, 1923.

quantity and quality is often attributed to the Middle West, but the error is unforgivable when emanating from Boston.

It is important to note that all national changes in standards have been *to* the metric system. No country, having once adopted metric units, has ever reverted to other standards of measurement. Metric advocates in this country and in Great Britain are people who have in practice used both the English and metric systems and who so much prefer the latter that they desire to use it exclusively and to teach their fellow-citizens its advantages.

Mr. Dale's statement that what we need is fewer and not more units is exactly our argument. From the educational point of view it is a great waste of time to teach two or more systems of measurement when one would suffice. It is our contention that the metric system is the one that should be retained because of its greater simplicity and usefulness. It has unlimited extension *decimally* in both directions and hence is suitable for the measurement of the smallest and largest quantities. The objection of metric opponents that metric units are not of convenient size is quite absurd. That factor depends entirely upon the thing to be measured. In financial matters which is the unit of most convenient size: the franc, the pound, or the dollar? Obviously a senseless question. If one has the advantage it is the dollar—not because of its size, but because of its decimal relations.

The attempt to decimalize English units must result in more confusion and little benefit because such decimalization is limited to the division of certain units. Some lengths are now recorded in feet and inches and others in feet and tenths. The recent proposal in Congress to construct an American decimal system of weights and measures, using the English units (with changed values), is the suggestion of worse confusion with the disadvantage of being different from the system of measurement in any other country. All this, however, shows the desire for decimal relations. The metric system offers the desirable features of any decimal system with the advantage of being universally understood, used in every other country except Great Britain, and probably to be adopted there.

Mr. Dale would leave us under the impression that metric usage has made no progress in this country during the sixty years that it has been permissive. This is far from the truth. Some important manufacturing companies have changed throughout their plants to the metric system and report a decided economy. There is no record that any such have changed back to English units. Many national trade and professional organizations have gone on record as desiring to use the metric system. These groups feel that they cannot make the change on their own initiative until their public is educated to the advantages of metric measurement. Practically

every advance in modern technology is due to the application of the physical sciences—in which the metric system is an appreciated tool. Back of the industries which still put most of their products on the market in pounds and gallons, the chemists and physicists are in careful control of the processes which they have more conveniently worked out in grams and liters.

The only criticism of the metric system of measurement which deserves serious consideration must come from persons who have thoroughly tried both metric and English units in actual use. If such persons can then give sensible reasons why they still prefer to use the English system, they shall have our courteous attention.

URBANA, ILLINOIS HARVEY A. NEVILLE

MAKE CHEMISTRY A REQUIRED HIGH-SCHOOL SUBJECT

I find that a great many people do not know what they are talking about; some don't know tin from zinc, others don't know concrete from granite, some think that where there is an ice cave there must be ammonia near at hand. There are many strange ideas among ordinary people. It is therefore astounding to my mind that educators in this country do not press for the requirement of chemistry in high-school courses.

To live and get the most out of life, to best enjoy the good things, and to best be able to solve the difficulties of life, we discover sooner or later that our problems work out better when we have some knowledge of the matters with which we have to deal. A great many times we come to the crossroads and must make a decision and it is the ratio of correct to incorrect decisions that determines our degree of success. To make good decisions requires knowledge. Knowledge comes from the study of English, mathematics, and chemistry, and such other subjects as we may desire, but today and tomorrow chemistry must be ranked of fundamental importance to every individual.

Chemistry is the study of the properties of matter and as we learn more about these properties we are able to make better and better use of this matter, which in one form or another constitutes everything in the universe. The white man is now producing beautiful colors and curative medicines from the coal the Indian sat upon.

The ordinary household is more contented if the furnace is run properly and if the proper food is purchased and properly prepared. The farmer is interested in foodstuffs, fertilizers, etc.; the mechanic in the properties of his metals, the baker in his dough, the painter in his pigments, the chemical worker in his chemicals. Our automobiles and storage batteries work

on chemical principles; so do our cleaning agents. The development of our modern metallurgical processes, glass, electric bulbs, textiles, leather, sugar, etc., all owe a great debt to chemistry. Chemistry touches everything from the celestial bodies to those of ultramicroscopic size; recently the combing of the great ocean has been undertaken for the gathering of its chemical treasures. The development of the seed which gives us a fruit or a vegetable or a beautiful flower, often accompanied by a delicate perfume, is essentially a chemical process. The ancient rock systems of our planet from which we get our coal, ores, building stone, etc., and which feed all of the multitude of vegetable life are the result of chemical reactions on a vast scale. The human system is the last of the complex and mysterious things chemical, with which the chemist has come to deal, and as he works along with the doctors and other scientists, as they unravel the profound nature of the glands, etc., we may look forward with deepest faith that the mystery of life will yet be solved, as the evolutionary story leads us to believe, and when chemistry has exerted its full power in the struggle, the rise from savage to superman will have become a fact.

In other words the science of chemistry is the most fascinating and vital of all the sciences. Everything has a chemical aspect viewed in one light or another. Chemistry stimulates curiosity, imagination, the desire to invent, caution, admiration for truth, in fact it might be called the science of infinite variety in the number of lessons which we might learn from it. Is it not agreed that chemistry should be made a compulsory course in place of one of the five or six language courses now given? It certainly seems to my mind that every high-school student (the majority of whom get no further education) should be the recipient of a good, broad, general course in chemistry, which I believe will give him: a better understanding of his daily work; a foundation on which to increase his knowledge if he so desires; and an optimistic philosophy.

WATERBURY, CONN. HARRY L. HUMPHREY

SCIENCE CLUBS

It would be difficult to find a high school these days where there are no science clubs and this extra-curricular work of the teacher is demanding the attention of educators more and more. It is furnishing material for some rather comprehensive theses for the Master's and the Ph.D. degrees. It is our opinion that neither the teacher nor the pupil is given sufficient credit for this work which is done voluntarily. In most schools the membership of these clubs is altogether voluntary and there is no difficulty in securing a membership of from twenty-five to fifty. The pupils as a rule are deeply interested and, being interested, undoubtedly derive much

of educational value, perhaps more of permanent value, than is derived from studies taken under compulsion.

The reader should have been present on December 15, 1925, at the Central High School, Philadelphia, when he would have been agreeably surprised at the very considerable interest manifested by both boy and girl students, teachers of science, heads of departments, and newly appointed director of science, in attending an Inter-High-School Science Association meeting to the number of nearly six hundred. In fact two of the largest lecture rooms were full to over-flowing and the complete program was repeated. Sponsors of the Chemistry, the Natural Science, and the Radio clubs, that is, the teachers of science, furnished the program. The talks as enumerated below required from ten to fifteen minutes each. Some of the talks were illustrated by unusual experiments and rarely seen material. A student, John Bennett, of the graduating class was chosen to preside over the meeting. Throughout the whole program there was undivided attention. Refreshments were served after a business meeting. The program was as follows:

Dreams and Musings in Chemistry.....Philip Maas
The Delaware River Bridge.....Claude B. Hagy
Face to Face through the Ether.....J. Howard Graham
How Plants Capture Sunlight.....Elmer B. Ulrich
The Smallest Thing in the Universe, and the Newest Rays.....
Edward H. Landis
Aladdin's Modern Wonderful Lamp.....Lloyd M. Knoll

J. H. G.

ELEMENTS OF COLLEGE CHEMISTRY

Last year I made a study of many of the widely used elementary chemistry texts with a view to adopting one to use in my classes this school year. I looked for one that was interestingly written, and teachable, yet thorough and sound and up-to-date.

I selected Foster's "Elements of Chemistry" (D. Van Nostrand Co.) and the results thus far have been most gratifying. Since the book is giving me such good service and so much pleasure in the teaching, I was much surprised at the tone and character of the review in the January JOURNAL. I could not help thinking that had the reviewer actually used the book or even made a careful study of it he would have had a different story to tell.

He opposes the unusual order of the earlier chapters, but "the proof of the pudding is in the eating;" my pupils, starting with the more familiar topics of the early chapters, avoided the customary cold plunge into the

unknown with its chilling effects. At the end of the fall term they have a very satisfactory knowledge of the fundamental laws and theories; are familiar with oxygen, hydrogen, nitrogen, carbon, and some of their compounds; and have mastered their chemical arithmetic with less difficulty than usual, and without requiring supplementary problems which I have previously had to prepare.

While your reviewer says that the book has "None of the 'rub it in element," my experience has been just the opposite, in fact, it is that element that most excites my admiration. The properties of acids, bases, and salts, after being briefly treated in the early pages, are enlarged upon and thoroughly "rubbed in" for twenty-six later consecutive pages, besides being frequently alluded to by reference and question throughout the remainder of the text.

Your reviewer states that the "index" has "one reference each to chemical equilibrium and explosives." Had he studied the text as well as the index he would have noted that chemical equilibrium is constantly kept before the pupil by careful explanation and sumptuous use of the reversible reaction equation, and that explosives are not only treated individually in logical order, but are repeatedly mentioned when their components or constituents are discussed.

The theory of the subject is explained in a convincing manner and industrial applications are stressed in a way to make the student realize the value, to him, of a thorough knowledge of the science. The laws of chemistry are connected to the theories that explain them with a clearness that should satisfy the most exacting.

The wealth and variety of material meets the requirements of all, and one may omit what he does not consider essential. (I shall omit several chapters because my course has for its primary object preparation for college entrance examinations.) The extensive use of bold type and italics, the splendid illustrations, the clear and logical presentation, supplemented with summaries and questions and references at the end of every chapter, make it the nearest my ideal as an interesting, sound, and teachable text that I have used or examined.

LAWRENCEVILLE HIGH SCHOOL, H. W. HEATH
LAWRENCEVILLE, N. J.

THE LAW OF AVOGADRO

Under the above caption I published a brief paper in the November number of the JOURNAL OF CHEMICAL EDUCATION, giving what I was pleased to call a deductive proof of Avogadro's law from the empirical and firmly established laws of Gay-Lussac and the law of Combining Masses.

In the January number of the same JOURNAL a letter appears which attacks my "deductive proof" (the quotation marks are those of the writer of the letter).

I would have welcomed the opportunity to reply to this criticism sooner, but this was impossible as it came to my notice only after its publication in the JOURNAL.

I shall pass over the writer's claim that "It is thoroughly familiar to all how this principle arises out of Gay-Lussac's Law of Combining Volumes and (as the author correctly points out) from the Law of Combining Weights," with this observation, that neither in Avogadro's memoir, nor in any text-book that I recall has the law of Combining Weights been explicitly stated, much less applied in establishing Avogadro's Hypothesis. However, his claim that "it is thoroughly familiar to all" may explain the uniformly obscure and scant treatment it receives at the hands of text-book writers and teachers of chemistry.

But it is in the next paragraph of his letter that my critic clearly discerns "the fly in the ointment." Thus he says "in the author's 'deductive proof' (quotation marks to this phrase are the critic's) the equation $V_1/V_2 = n_2/n_1 \times N_1/N_2$ is used, where V_1/V_2, the ratio of combining volumes and N_1/N_2 the ratio of total molecules reacting, *are both whole numbers* (the italics are mine. May I interject at this point that the *ratios* are not whole numbers; it is the *terms* of the ratios that are whole numbers) *whence*, the author suggests n_2 cannot be *not* equal to n_1 (the number of molecules in equal volumes)."

Then follows this, "The mathematical fallacy of this is apparent, however, for to fulfil the conditions it is only required that $n_2 = bn_1$, where b is *any* whole number not necessarily one."

Of course; *but* by what right does he confine the values of b to *whole* numbers? Why may not b be any number whatsoever, whole or fractional? Does he wish to claim, taking any two gases at random, that the number of molecules in unit volume of one of them *determines* the number of molecules in unit volume of the other. That is what he is doing when he writes $n_2 = bn_1$. Such a view is absurd. n_1 and n_2 are independent. We cannot say, for example, that the number of molecules in unit volume of hydrogen is proportional to (or indeed any function of) the number of molecules in unit volume of oxygen. Surely it is unnecessary to elaborate this further.

I showed in my paper that if n_1 is not equal to n_2 the condition required, *viz.*, that V_1/V_2 follow Gay-Lussac's law could not be satisfied in all cases, *i. e.*, for all values that n_1 and n_2 could assume (and I cited a possible particular pair of values of n_1 and n_2 to illustrate this point). It should be realized that Avogadro's Law is a limit law just as are those of Charles, Boyle, and Gay-Lussac as, in fact, I stated in my paper.

Therefore I hold that my "deductive proof" is neither "erroneous" nor "ambiguous," and that the mode of presentation employed does get us somewhere with respect to this fundamental law (not "assumption") of Avogadro.

ABRAHAM HENWOOD

CENTRAL HIGH SCHOOL,
PHILADELPHIA, PA.

Fresh Water Film Covers Briny Ocean. "The Ancient Mariner never would have thirsted for water if that old sailor could have taken a film of water about 0.00000004 centimeter thick from the surface of the ocean," according to Prof. W. D. Harkins, chemist of the University of Chicago.

Any solution of salt water, he explains, has a thin film of pure water surrounding it. The volume of the solution may vary from a drop to an ocean, but the film is always present. The amount of salt dissolved in a given amount of water determines the thickness of the film. A dilute solution of table salt has a film of pure water about 0.00000004 centimeter thick around it; a concentrated solution has a film 0.000000024 centimeter thick. The film becomes thinner as the amount of salt increases.

The thickness of the water film in the concentrated solutions is almost identical with the thickness of a salt molecule, 0.000000035.

"All physical matter, from a shark's tooth to a dust particle, has a film surrounding it which is different in composition from the main mass of the substance," Prof. Harkins explained. "Our work is still in an early stage, and as progress is made it will prove to be of value to our great industries, such as soap making, leather tanning, dairying, and meat packing, in which the chemistry of colloids plays an important part."—*Science Service*

Universe Not Running Down Says California Chemist. In the course of the Silliman Lectures which Prof. Gilbert N. Lewis of the University of California is giving at Yale University he showed that the acceptance of the Einstein theory of relativity abolished the idea of the older physics that the universe is running down like a clock. According to views hitherto held it seemed that all forms of energy tended to become dissipated and eventually diffused throughout space, and this pointed inevitably to a period in the far future when the universe would come to a standstill forever. Any physical system left to itself would in the long run arrive at this state of run-downness, the degree of which scientists call entropy.

But Professor Lewis pointed out that according to the new geometry of the relativity theory this would not hold true, for the chance that the system would again return to its original state of high potential energy without any outside interference could be calculated, and that this event would necessarily ultimately take place. Thus all phenomena of the physical world are reversible in space-time. Past and future are therefore alike and there is no one-way drift of the universe as a whole.

But in our consciousness time appears to flow in one direction. Our vital processes are irreversible. Life proceeds in one direction from birth to death. Vital phenomena, therefore, do not come under the domain of the physical laws. All irreversible processes result from living things which are cheats in the game being played by physics and chemistry.

Professor Lewis's lecture is regarded as a blow to the mechanism theory which prevailed during the past century and is somewhat in line with the "Creative Evolution" of Henri Bergson.—*Science Service*

Chemical Digest

EDITORIAL PARAGRAPHS

OUR attention has been directed to an editorial on "Evaluating Ideas"[1] from which we quote the following paragraph:

Chemists are frequently called upon to evaluate ideas of their own and those of other people. In research, this is a matter constantly present. In industrial research, the element of market and profit must be considered from the beginning. In the wider field of manufacturing, the soundness of ideas enters largely into profit and loss. Occasionally, a single idea floats a company to great prosperity; and failures of what were "safe" organizations may be traced to the pursuit of unsound ideas.

Again, from the same source comes this paragraph:

Those who have followed an original idea through its process of reasoning, through its embryonic laboratory or manufacturing states, through its plant production and marketing stage, perhaps through patent difficulties, and have met up with all the various kinds of resistances, real and imaginary that can, and do, surround everything new or newly undertaken, have gained something that will always be foreign to the individual who has a knowledge only of the operation of a more or less established system. There is, perhaps, a larger place for chemists in their consulting capacities as business economists, if they will but apply their training in being critical of their own work to the many problems of manufacturing and business. They have a host of viewpoints to bring, that do not come so readily to many business men; they should possess a rather valuable set of interrelated facts tucked away in their experience; they should have a facility for thinking in terms of several industrial groups at one time; they should know the literature well enough to seek out submerged danger points; they should have an international viewpoint that is often valuable; and they should be able to acquire the general common rules of the game.

ROLLO Walter Brown in his book, "The Creative Spirit," says, "In America, where we boast of being especially concerned with progress, creative mindedness is usually neglected, it is often positively stifled, and it is not infrequently treated as a symptom of grave disorder." A review of this book in *Chemical and Metallurgical Engineering* elicited the following editorial comment:[2]

Education, we agree, too often lacks the "quickening" teacher. Many a university organization suffers from inadequate coördination; and the teacher fails to elicit a helpful spirit of sympathy in his problems and aspirations. Bigness, we read, is not always a sign of health; it often leads to fatty degeneration.

If we should become gravely and earnestly concerned with the making of smaller, less cumbersome units in education—units in which the individual need be neither

[1] *Can. Chem. & Met.*, **9**, 257 (1925).

[2] "Scope for Initiative and Inventiveness," *Chem. & Met. Eng.*, **32**, 907 (1925).

coërced nor lost—we could find means of doing so.....It is even proposed that the system of individual colleges in vogue at the two leading English universities might be employed as a point of departure. In other words, a redistribution is favored, which would not involve a duplication of work.

"IDEAS Should Have Concrete Expression," says another editorial.[3] We call your attention to the following paragraphs:

But even in these days of a better understanding of just what education means, there is often a failure to appreciate the truth that it is the outward physical expression of a mental state that makes it real. Glib parrotings still pass in many schools as the end of school work. Teachers often lose sight of the psychological truth that without expression in some outward form the mental state is pale and shadowy. What goes on in the mind is really never there in the psychological sense until it has been expressed in some outward form. Externalizing an idea in some way, putting it off from us, is the only way to gain real possession of ourselves. . . . . .

Long continued study with no opportunity for the expression of knowledge in life's activities is too likely to make dreamers rather than doers. Rehearsing the opinion of others, memorizing facts ascertained by others, going over and over the weary round of second-hand information, as is not infrequently done in high-school classes, is it any wonder that the high-school student seems at times, to lack forcefulness and initiative?

THE work of the Department of Scientific and Industrial Research, established by the English government in 1915, is made the subject of comment in *Nature*.[4] We quote the following:

At the first meeting of the British Association, held 1831, the Rev. W. Vernon Harcourt proposed that the Association should "employ a short period of every year in pointing out the lines of direction in which the researches of science should move; in indicating the particulars which most immediately demand attention; in stating problems to be solved and data to be fixed; in assigning to every class of mind a definite task; and suggesting to its members that here is a shore of which the soundings should be more accurately taken, and there a line of coast along which a voyage of discovery should be made." This early suggestion adumbrating the organization of scientific research met, apparently, with no response, and academic research continued to be conducted entirely on individualistic lines until a few years ago, when a government department undertook the organization of certain investigations which were realized to be of fundamental and national importance.....The seeds of State-aided organization of science were sown well back in the 19th century, but credit for having transformed "an amorphous mob of scientific workers" into something resembling "an organized army" belongs to the department of Scientific and Industrial Research. The department has been very successful in directing the choice of directors of research upon whom much depends and in allowing them free hand.

Of the more distant future, one can speak with less assurance and with less optimism. For years past there has been marked tendency for industrial firms to amalgamate, or to pool their resources and interests in other ways, the latest development in this direction being the unification of all large German chemical companies into a huge corporation with a capital of about £32,000,000. To what extent such aggregations are de-

[3] *Am. Educ.*, **29**, 105 (1925).

[4] "Coöperative Research." (Editorial.) *Nature*, **116**, 853-5 (1925).

sirable from the points of view of the home consumer and the nation is a matter of opinion, but there is no doubt that large corporations can, and do, dispense with extraneous aid in carrying out all the research work they require, whether it be fundamental or incidental.

There will be less diversity of opinion concerning the truth of the Prime Minister's statement (quoted in the report of the department) that our trade will never be able to cope with unexpected emergencies, at home or abroad, until scientific method and scientific men occupy a better position in industrial affairs. Why the position of the scientific man is inferior to that of the financier and administrator, to what extent he himself is responsible, and how far it is due to the inherent and uncorrected perversity of others, are questions outside our present scope, but they all seem to center around the larger problem of how to bring home to the people a sense of the actual and potential value of science in the maintainance and perfection of human life. Much of that value lies in research; and just as Malebranche declared that if he held truth captive in his hand, he would let it escape so that he might pursue and capture it again, so we may say that if we held world supremacy in science and industry, we would let it go, so that we might be forced to use research in the struggle to regain it.

W. R. W.

THE ROYAL ROAD

"I have heard a good many definitions of education, but I know of none better than this—the development of one's capacity to understand."[1] Each one of us will, no doubt, concede to Mr. Munro that definitions of education are not lacking. However, we may not agree quite so readily that the one to which he refers satisfactorily conveys our idea of the true meaning of the word. "He that would bring home the wealth of the Indies must carry the wealth of the Indies with him" is very applicable in this case and so each individual finds a different meaning in "education." What is your idea of education? Quoting further from the same author:

"Education is not merely a matter of assimilating various chunks from the world's stock of accumulated knowledge, although there are a great many people, both old and young, who look upon it in that light. In much larger measure, education is the process of training men and women to realize the range and the profundity of their own ignorance."

Our attention is again called, in the same article, to the tendency of people in general to seek a "royal road to learning." Nor is that tendency restricted to learning alone but persists in showing itself in the process of reaching any end which we set out to attain. We must get where we are going in not only the shortest time possible but also with the least possible effort. Mr. Munro says:

"The quest for a royal road is being given up, and what people are now

[1] "Scientific Education and Unscientific Democracy," Wm. Bennett Munro. *Harvard Grad. Mag.*, **34**, 175–85 (1925).

seeking, apparently, is a system of rapid transit in education. Hence, we have, almost every year, the reputed discovery of some new educational alchemy whereby we can make a silken purse out of a sow's ear, a job that is simplicity itself when compared to the task of transforming mental vacuity into genius. The problem method, the project method, the Meiklehohn method, the socialized recitation—they all point to the fact that some educators have not yet abandoned the hope of attaining the end without the means, the whole without the parts, the reward without the effort. There is nothing new in any of these methods except a new name. They are merely the Gold Dust twins of education which advertise that work can be done without doing it. No one of them, or all of them put together, can ever accomplish much as a substitute for sustained intellectual exertion. In the catalogue of a certain Eastern institution there is an announcement of an elementary course in which the instructor says: 'The purpose of this course is to make freshmen think.' I have no fault to find with his goal, although I am disposed to wonder why this particular form of hazing should be confined to freshmen. But is it not a strange delusion that men of any age can be *compelled* to think, or that thought which is induced by compulsion can ever be of value to anybody? If that were the case we need only add an Eleventh Commandment to the Decalogue, namely, 'Thou shalt think,' and all other things would be added unto us."

Now, if we have failed to think for ourselves while *acquiring* an education, are we justified in assuming that we have been educated?

"Learning to think in a rational, orderly, objective way is a long and difficult process, far more so than most people imagine. Thousands of our young men and women go through the schools and colleges without mastering the art, and hence without obtaining a real education.

"Now it is the glory of pure science and mathematics that these subjects train men in orderly and objective thinking as no other subjects can. Here are fields of study in which loose or crooked thought leads inevitably to demonstrable error, to error which cannot be glossed over or concealed. Here are branches of knowledge in which there is no confusion between right and wrong, between *post hocs* and *propter hocs*, between the mere coincidences and the consequences of the cause. When you have finished with a problem in any of the exact sciences you are either right or wrong, and you know it. That is why we call them exact sciences, to distinguish them from philosophy, sociology, economics, and the other social sciences, in which the difference between truth and error is still, in most cases, a matter of individual opinion.

"It is sometimes said that the scientist renders a great service to mankind by the discovery of new ideas. But it seems to me that he renders an even greater service by exploding some of the old ones." W. R. W.

ABSTRACTS

High Frequency Rays of Cosmic Origin. ROBERT ANDREWS MILLIKAN. *Science*, **62**, 445–8 (1925).—A report read to the National Academy of Sciences, Madison, Nov. 9, 1925, of an investigation of the so-called "penetrating radiation" of the atmosphere.

Rutherford and McLennan (1903) showed that the slow leakage of an electric charge from an electroscope could be lessened by enclosing the apparatus in a thick-walled metal box, thus proving this part of the leakage was not due to imperfect insulation, but rather to radiation similar to the gamma rays of radium. The radiation was supposed to proceed from radio-active material in the earth till Gockel (1910–12) and Hess and Kohlhorster (1912–13–14) showed by electroscopic measurements in balloons that the radiation was greater at high altitudes. H. and K. found at 5.6 miles eight times the radiation at the earth's surface.

The work described in this paper was begun in 1922 by the author and I. S. Bowen at Kelly field. They used four small recording electroscopes which were sent up in balloons, one of which reached an altitude of nearly ten miles. The results proved conclusively that the "penetrating radiation" was greater at high altitudes but not so much greater as was expected in view of the previous work of Hess and Kohlhorster. They, however, have since verified the lower figures.

In the summer of 1923 observations were taken on the top of Pike's Peak by the author and Mr. Russell Otis. Here the electroscopes discharged about twice as fast as at Pasadena. The rays were found to be of two varieties—one of about the penetrating power of the gamma rays of radium and the other of very penetrating character. Most of the increase between Pasadena and Pike's Peak was of the softer (less penetrating) rays.

In the summer of 1925 further work on both varieties of radiation was carried on by the author and Mr. Harvey Cameron at Muir Lake and at Arrowhead Lake. These lakes were chosen because of their altitude and because they are snow fed, thus insuring water free from radio-active contamination. Electroscopes were sent to various depths up to sixty feet. At Muir Lake the penetrating rays were not all absorbed till a depth of forty-five feet was reached. As the air above Muir Lake is equivalent in absorbing power to twenty-three feet of water it takes the equivalent of $23 + 45 = 68$ ft. of water to stop these rays. This is equivalent to six feet of lead. These rays are more penetrating than any previously imagined as the hardest (most penetrating). X-rays cannot go through one-half inch of lead. The rays come from all directions as no differences were observed at different times of day or night, also they are not homogeneous as the electroscope readings decreased gradually with increasing depth.

High penetrating power means high frequency or short wave-length. Using a formula which gives reliable results in the region of X-rays and gamma rays, but which is, of course, unproved in this new region, the wave-length of the most penetrating of the new rays is calculated to be 0.0004 Angstrom or about $^1/_{50}$ that of the shortest gamma rays and one ten-millionth that of ordinary light. The longest wave-length found was 0.00067 Angstrom. This is a region as far above the X-rays as X-rays are above ordinary light. When such rays strike the earth they should be transformed into softer radiation of about the wave-length of that observed on Pike's Peak. This is held to be the best solution of the origin of the softer radiation. To account for the even distribution of these penetrating rays it is necessary to assume that their origin is in widely scattered centers at great distances from the earth.

As the shortest rays previously known (gamma rays) arise from nuclear changes in the atom it is assumed that these extraordinarily short rays also arise from nuclear changes in the atom but having an energy value of perhaps fifty times that of the former. The energy of the nuclear change which corresponds to the formation of helium out of hydrogen is known and a calculation of the wave-lengths of the radiation produced by this "reaction" gives figures which correspond to the highest frequency rays observed. They also check closely with values for the capture of an electron by a positive nucleus.

The author concludes: "(1) That these extraordinarily penetrating rays exist; (2) that their mass absorption coefficient may be as high as 0.18 per meter of water; (3) that they are not homogeneous, but are distributed through a spectral region far up above X-ray frequencies—probably 1000 times the mean frequencies of X-rays; (4) that these hard rays stimulate, upon striking matter, softer rays of about the frequency predicted by the theory of the Compton effect; (5) that these rays come into the earth with equal intensity day and night and at all hours of the day or night, and with practically the same intensity in all directions." G. H. W.

Flames of Atomic Hydrogen. IRVING LANGMUIR. *Science*, **62**, 463–4 (1925).—

The abnormally high heat losses from tungsten filaments at very high temperatures in atmospheres of hydrogen led to the conclusion that hydrogen is largely dissociated into atoms at temperatures of 2500°K. or more. The dissociation at atmospheric pressure was found to increase from about 2% at 2400°K. to 34% at the melting point of tungsten. The heat of combination of two grams of the atomic hydrogen thus formed was found to be 90,000 small calories. Other properties were observed such as extreme chemical activity and high solubility in metals at ordinary temperatures. By causing the dissociation to take place in an arc between tungsten electrodes in an atmosphere of hydrogen the atomic hydrogen could be blown out of the arc by a small jet of hydrogen. Its combination to the molecular state formed a flame of atomic hydrogen of very high temperature which liberated about 50% more heat per gram-molecule than the oxy-hydrogen flame. Small rods of iron, molybdenum, and tungsten melted quickly, quartz with more difficulty, in this flame. The flame shows promise of great value in welding because of the possibility of excluding contaminating substances such as C, O, N, and because fluxes are unnecessary. G. H. W.

Chandler: The Teacher and the Chemist. M. I. PUPIN. *Science*, **62**, 499–501 (1925).—An address delivered at a Memorial Meeting, in honor of the late Charles Frederick Chandler. P. tells of Chandler's difficulty in finding suitable employment upon his return from Göttingen in 1857, and of his acceptance, in order to work with Professor Joy, of the position of janitor in the chemical laboratory of Union College.

The founding of the School of Mines at Columbia and Chandler's pioneer work on sanitary engineering, nursing, and public health in New York are outlined. The address ends with a tribute to the inspiring work of Chandler as a teacher of chemistry. G. H. W.

The National Academy of Sciences. Abstracts of Papers Presented at the Madison Meeting. *Science*, **62**, 519–24 (1925).—The following papers were presented: Proper motions of stars obtained with the blink microscope, by Frank E. Ross; Radial velocities of 368 helium stars, Edwin B. Frost, Storrs B. Barrett, and Otto Struve; The constancy of the light of stars, by Joel Stebbins; Recent physiographic observations in the Laramie Range, Wyoming, by James Furman Kemp; When certain mathematical formulas become true, by G. A. Miller; Hysteresis and atomic magnetostriction, by G. W. Stewart and R. L. Edwards; A spectroscopic study of the excitation of mercury vapor by positive ion impact, by B. M. Knutson and John T. Tate; Polarization of resonance radiation in magnetic fields, by A. Ellett; A study of the thermal properties of air, by J. R. Roebuck; Polarized summary of paper on diffraction of X-rays by a ruled grating, by A. H. Compton and R. L. Doan; Direct proof that conduction electrons in metals at ordinary temperatures do not share in the energy of thermal agitation, by R. A. Millikan; Chemical decomposition by collision with activated molecules, by Farrington Daniels; The importance of light for the maintenance of animal life, by H. Steenbock and E. B. Hart; The isotopic composition and the atomic weight of terrestrial and meteoric chlorine, by William D. Harkins and S. B. Stone; The separation of chlorine into isotopes (lighter isotope), William D. Harkins and Francis Jenkins; Distribution of sizes of droplets in emulsions, by William D. Harkins and Norvil Beeman; Polymolecular and monomolecular films, by William D. Harkins and J. W. Morgan; The surface tension of water at various temperatures, by T. F. Young, P. L. K. Gross, and W. D. Harkins; The problem of the cerebral cortex, by C. Judson Herrick; American coal balls, by A. C. Noe; The direct results of Mendelian segregation, by Charles E. Allen; Insect transmission and host range of aster yellows, by L. O. Kunkel. G. H. W.

The Engineer and Civilization. W. F. DURAND. *Science*, **62**, 525–33 (1925).—Presidential address at the annual meeting, New York, Nov. 30 to Dec. 4, 1925, of the American Society of Mechanical Engineers. The first part of the paper takes up the historical background of the engineer, his early appearance in the development of civilization, and the dependence of modern civilization upon the engineer; the latter part of the paper consists of a discussion of the problems confronting the engineering profession and the duties of the engineer toward his profession as well as toward society in general. G. H. W.

Biological Abstracts. J. R. SCHRAMM. *Science*, **62**, 533–6 (1925).—Statement of present status of plans for the new periodical. *Biological Abstracts* is made possible by the favorable attitude of American biologists and by the pledge of $350,000 by the Rockefeller Foundation. It will begin its work with the literature of 1926 and the first issue may be expected about May or June, 1926. "Except during its first year it will appear as twelve monthly abstract numbers, the annual volumes, which will coincide with the calendar year, closing with an index number." Three indexes have been de-

cided upon (1) Author's index, (2) Detailed analytical alphabetic subject index, (3) Subject index arranged by systematic groups. More may be added. *Botanical Abstracts* and *Abstracts of Bacteriology* will be merged with the new periodical but by using special paper and a double-column page, similar to that in *Science*, it is expected, without sacrifice of legibility, to accommodate about five times as much material per inch of shelf space as is now found in *Botanical Abstracts* alone.

J. R. Schramm has been appointed editor-in-chief and J. A. Detlefsen and F. V. Rand associate editors. Business management and subscriptions will, for the present, be handled at the editorial office—address Biological Abstracts, University of Pennsylvania, Philadelphia, Pa. G. H. W.

The Scientific Accuracy of the Sacred Scriptures. W. W. KEEN. *Science*, **62**, 543–4 (1925).—A protest against the failure of Dr. W. B. Riley, of Minneapolis, to make suitable corrections in his book of the above title after his attention had been called to the falsity of certain statements regarding recent chemical work. The paragraphs in question are quoted, together with the correspondence in regard to them. G. H. W.

Enrolment in 50 Accredited Universities and Colleges in Pennsylvania, 1925–26. ANON. *Penna. Sch. J.*, **74**, 181 (1925).—Enrolment is given for each one of the 50 and totals 55,359 students. For the total enrolment of the 14 normal schools of the state as of Oct. 1, 1925, 8016 registered students is given. The enrolment for the individual universities is as follows: University of Pennsylvania, 14,416; Temple, 8275; Pittsburgh, 6764; Pennsylvania State, 3437; Lehigh, 1363; Bucknell, 1040.

J. HOWARD GRAHAM

My Educational Creed. MARGARET M. BURRELL. *Penna. Sch. J.*, **74**, 228–9 (1925).—Burrell expands very fully the following outline of her creed of education. She believes in EDUCATION. It has meant a livelihood gained at the work which she loves. At the outset she must adjust her life in harmony with her Creator. To be a good teacher she must catch a VISION. She must be HEALTHY. She must be prepared; cultivate the right attitude of mind; open-minded in all that pertains to her profession; must be ever learning; forward-looking; loyal; must have well-defined aims. She believes in EDUCATION. J. HOWARD GRAHAM

Enlarging the Horizon of High-school Pupils. E. LOUISE NOYES. *Sch. Rev.*, **33**, 671–4 (1925).—"Most people of mature years realize how little they know as compared with what they would like to know. Most seniors in college could easily spend another three or four years of study in taking courses which they would really like to pursue." The belief that high-school pupils share this common desire gave rise to the idea for a series of courses that should satisfy the demand.

Before any definite steps were taken, the plan was discussed with both pupils and teachers. After an informal discussion, the pupils were asked to hand in unsigned slips naming the courses in which they would be interested. Their response was immediate and enthusiastic. The plan of the popular courses was to provide both enjoyment and information in subjects for which the pupils had no time during their regular courses. Weighted credit was given for these courses, two points for excellent work and one point for good work, with the hope that few pupils would be interested in credit alone. The response of the pupils when asked for comments justified the time and effort involved. From the standpoint of the teachers the courses were worthwhile in several ways. They gave the teachers the chance to meet the pupils outside their own departments and to meet them rather informally and a chance to organize their own hobbies, and thus to get greater pleasure from them as well as to inspire others to follow the same subjects. W. R. W.

Science as a Social Factor. E. E. SLOSSON. *Prog. Educ.*, **2**, 221–4 (1925).—"Science has succeeded in making itself useful to the world in a thousand ways that were beyond the vision of the farthest sighted of its friends of former ages, but it has signally failed to fulfil their fond expectations as to what it might do in the way of providing an inspiring and practical philosophy of life."

The eighteenth century was distinguished, the author says, by its effort at an all-embracing point of view and its belief that science should contribute to human welfare. The nineteenth may be called an analytic century while the twentieth may be considered as a century of syntheses.

"The aim of scientific investigators is to reduce the raw material of nature to a compact, impersonal, and permanent form; to extract from millions of miscellaneous facts a single and simple formula that is applicable to all similar cases. It is by means of this method that modern science has made such unprecedented progress.

"Antagonists of scientific education do not question the achievements of applied science, they do not object to the pursuit of pure science, they do not deny the practical

advantages of elementary education. What they do question is the esthetic, intellectual, and moral benefit of scientific training; that it can stimulate the imagination, broaden the sympathies, clarify the mind, and elevate the character. In short they challenge the cultural value of science."

Many colleges are introducing survey courses in the freshman year. These are also needed in high schools, according to the author.

"If science teachers merely teach their students to use the appliances of science and fail to train them in the scientific way of thinking, they may find the intellectual aims of science defeated by the machinery of science. The main object of science teaching is to inculcate the scientific habit of mind which consists in constantly looking for the reasons and relations of things seen about one." W. R. W.

A Biochemical Study of By-product Yeast. J. S. HEPBURN. *J. Frank. Inst.*, **200**, 767–70 (1925).—This article treats of the substitution of the by-product of the manufacture of industrial alcohol from corn (distillers' grains) for wheat millings in poultry feed. Distillers' grains were found to be more efficient than the wheat millings and this was attributed to the presence of yeast as well as to the increased relative amounts of protein and fat. These results led to a search for the water-soluble vitamin B in yeast and experiments showed it to be present. The presence of this important vitamin in trade wastes presents many possibilities for the application of such wastes as a constituent of food for both man and domestic animals. J. HOWARD GRAHAM

Chemical Training for Non-chemists. H. G. WENDT. *Chem. Bull.*, **12**, 289 (1925).—In the United States may it not be that we are over-exploiting chemistry as a professional study and under-emphasizing it as a cultural one? Industry has a surprising ability to absorb trained chemists but the majority of them remain actively in minor positions. Is this condition a result of preference or training? Instead of criticising those who, even though chemically trained, yet go to other lines of work should we not rather congratulate both them and ourselves for so doing? "The more chemically trained men there are in other lines of endeavor the easier it becomes for chemistry to accomplish its task of service for the race. After all chemistry is a means to an end and not the end itself." B. CLIFFORD HENDRICKS

Our Smoke Problem. HERMAN N. BUNDESEN. *Chem. Bull.*, **12**, 279 (1925).—Why is smoke a problem? Perhaps this can be answered in terms of cleanliness, health, and economy. "Clean air and a maximum amount of sunshine are the two great health factors that save lives and aid in lowering the incidence of the respiratory diseases in winter. . . . . Clean air is no less imperative than pure food and water. It is the common practice to pay very little attention to air, although the utmost attention is paid to the purity of food and water." The reason for this difference may be found in the fact that the effects of contaminated food and water appear quickly.

Smoke-laden air cuts down the amount of sunshine and filters out the life-giving ultra-violet rays which have almost the identical effect of vitamin A in preventing rickets in babies. It is claimed that a smoky atmosphere cuts off at least fifty per cent of the ultra-violet rays.

The smoke, according to the author, is due to wrong firing and each fuel user by wasteful, careless firing of his heater is contributing to the dirt supply in the air. Coal is burned most efficiently when no smoke is produced. Neglect of the heaters and furnaces is the cause of the smoke and a remedy can be found in the selection of the proper fuel which the heater is designed to burn.

The demand for cleaner air is heard through civic organizations and women's clubs. The women are especially concerned since the effect of smoke is felt in the home more than anywhere else. B. CLIFFORD HENDRICKS

Formalism an Ever-present Danger. R. H. ECKELBERRY. *Educ. Rev.*, **70**, 236–40 (1925).—One of the besetting sins in our intellectual life is a tendency to formalism. The term is used to designate the emphasis on particular methods, routines, devices, or formulae to the neglect of the aim for the attainment of which they have been developed. E. shows how this mistaking means for ends has been present throughout the growth of education from the Italian Renaissance to the present day. The humanistic secondary school became the accepted type in every country but the great majority of teachers failed to appreciate the real purpose of humanistic education. The Pestalozzian movement is another outstanding example. And now the testing movement and project method are in grave danger. E. suggests two ways to minimize this danger. First to insist that our teachers and administrators be trained not only in the technique of their profession but also in its philosophy. Secondly we can keep ever before our eyes the danger of mistaking means for ends—of formalism.

H. K. M.

Artistry in Teaching. X. J. GALLAGHER. *Educ. Rev.*, **70**, 241–5 (1925).—With his interest centered primarily upon scholarship, the teacher of the higher branches has felt that method in college instruction is distinctly secondary to subject-matter. As more and more students are coming to college the problem of instruction is becoming increasingly difficult and it becomes necessary to give more thought to technique. There is an art in teaching. There are various methods of teaching which might well be considered as the most common tools of education. Three methods are selected for discussion because of their almost universal usefulness in widely varied fields. Each has its strong points and its weaknesses. Skill in teaching demands a recognition of these facts and the conscious adaption of technique with this knowledge in mind.

The lecture method has an honorable past, a widely respected present, and with due recognition of its limitations it has in all probability an assured future. As a method of conveying elementary, textual information it is an absolute injury to education. This use constitutes its great weakness and is a misuse due in large part to a lack of consideration of craftsmanship. G. dwells at length on the merits and demerits of the lecture system.

The advantages of the recitation or class-room discussion method are so generally acknowledged that it is scarcely necessary to recall them. The danger lies rather in the fact that the recoil from the lecture method has encouraged an indiscriminating reliance upon the recitation which is harmful to good teaching.

The conduct of a college course by the assignment of special topics or problems is perhaps less generally used than either of the two other forms. It undoubtedly demands the hardest kind of teaching; the ability to direct a student in the creation of his own course is probably less widely distributed than the ability to lecture or to conduct incisive recitations. If properly administered it will lead to the highest advantage.

In the art of teaching as in other arts personal vision must be added to aptitude. It is the intelligence and personality behind the method that vivify it. H. K. M.

More Dangers of the Doctorate. W. C. TROW. *Educ. Rev.*, **70**, 254–9 (1925).—Are our colleges manned by persons so narrowed by inclination and training that they are lacking in that broad appreciation of men and things that distinguishes a scholar from a pedant, and that makes a man an able teacher and a real influence in the lives of his students? Columbia University seemed an ideal place to find this out both because of the high type of graduate students which are drawn to it as one of the foremost graduate schools of the country and because of the exceptional opportunities which New York City affords for cultivating wider interests. A number of questions were addressed to advanced students. After an interesting discussion of the replies T. concludes that in the main, candidates for the Ph.D. degree, the college teachers of tomorrow, are narrow in their interests and that this narrowness grows still more narrow during the period of their graduate study. T. would insist on sound scholarship first; second upon professional preparation in the field of education and third, intelligent interest and participation in and appreciation of the things the world has found good. H. K. M.

Bismuth Trihydride and Silver Bismuthide. E. J. WEEKS AND J. G. F. DRUCE. *Nature*, **116**, 710 (1925).—A discussion of methods of preparation and properties. H. K. M.

Some Modern Aspects of Physical Research. A. EWING. *Nature*, **116**, 713–5 (1925).—E. points out that there are two general types of research, both of which it is the business of a scientific society to foster. There is the inspired type—the flash of genious, of intuition, of imagination which breaks new ground or brings the old into a new harmony by some far-reaching generalization. There is also the plodding, everyday, systematic spade-work of research; a kind which goes on in a hundred laboratories; not inspired, not spectacular, not in the least intoxicating; but we should make a grave error if we were to underestimate its importance. An interesting review of the scientific advances of a lifetime is given. While we may justly feel pride in all this progress and achievement, it is mingled with a consciousness of mystery, with a spirit of question. In a special sense it is true today that the widening of the circle of light has widened the circumference of darkness and for the moment at least the darkness seems strangely impenetrable. H. K. M.

Michel-Eugene Chevreul, 1786-1889. H. E. ARMSTRONG. *Nature*, **116**, 750–4 (1925).—A review of C.'s accomplishments in relation to our present knowledge. H. K. M.

The Occurrence of Dwi-manganese in Manganese Salts. V. DOLEJŠEK AND J. HEYROVSKÝ. *Nature*, **116**, 782–3(1925).—During investigations of the electrolytic deposition potentials of manganese solutions by the use of the dropping mercury cathode and the automatically registering "polarograph," comparatively large impurities

(1:20,000) were detected even in the purest samples. At the potential at which the manganese impurity is distinctly shown, *i. e.*, at —1.0 volt (from the calomel zero), zinc, nickel, cobalt, and iron may be deposited from their 10^{-5} molar solutions. From different heights of the humps on the polarographic curves, the impurity in the manganous solutions can be estimated at $0.5–4.0 \times 10^{-4}$ equiv. per liter. Analytical tests for zinc, nickel, cobalt, and iron gave negative results and the persistent impurity was suspected to be composed of analogues of manganese—eka-manganese (43) and dwi-manganese (75). Methods of separation are given. X-ray spectrum was examined. One of the humps is due to element 75. Whether the other hump is element 43 could not be determined as the coil used would not withstand the powerful exposure for the K-series of element 43. Chemical properties are given. D. and H. point out that the spectroscopic evidence of Noddack, Tacke, and Berg (for abstract see THIS JOURNAL, **2**, 939 (1925)) is not conclusive since two of their β lines of the L-series of element 75 coincide with those of tungsten and their $L\beta_2$ and $L\beta_3$ for element 75 coincide exactly with $L\alpha_1$ and $L\alpha_2$ for thallium. H. K. M.

The Greatest Waste in Education. EDITORIAL. *J. Educ. Res.*, **12**, 311–4 (1925).—A comparison may be made of waste in industry and waste in education but all analogy ceases with the product formed which in one case is referred to a lifeless object and in the other to a person with "astonishing abilities, most of them his in spite of the school." The greatest waste in education is found in the lack of use made of things learned in school, after students have graduated. Individuals should conserve education by constant renewal of their early acquaintance with English literature, economics, Latin, philosophy, and science, and thus avoid the irreparable loss of things of great value given them in youth. R. M. P.

Orgie Visits Spain's Olive Orchards. LENA C. AHLERS. *Sch. News*, **39**, 20–1 (1925).—A story which includes chemical facts for grade pupils. R. M. P.

The Ethics of the Teaching Profession. J. ORIN POWERS. *J. Educ. Res.*, **12**, 262–74 (1925).—A summary of all available material bearing on the topic is given together with valuable correlations and tabulations by the author. There are two types of codes, one being a discussion of principles underlying professional conduct and the other a statement of rules for professional conduct. Illustrations of each type are discussed in detail. R. M. P.

The Correlation between College Lecture Notes and Quiz Papers. C. C. CRAWFORD. *J. Educ. Res.*, **12**, 282–91 (1925).—The findings in this research show a positive correlation between the number of points recorded in lecture notes and the number recalled at time of quiz. Full and definite notes are more effective than those taken briefly. Only a small per cent of the points omitted in notes are written in the quiz papers. The author believes that time should be given early in the course to teaching the best procedure in the taking and study of notes. R. M. P.

The Predictive Value of the I. Q. D. H. LOREE. *Am. Sch. Board J.*, **71**, 53–5 (1925).—The I. Q. is closely related to the general field of education. It is constant through primary and secondary periods of education and a valid basis for predicting probable progress later. The I. Q. has a high value in indicating subjects which pupils should elect and aids teachers to decrease failures. SY

The Open Door in Education. F. D. BOYNTON. *Am. Sch. Board J.*, **71**, 68 (1925).—Present methods of admitting students to colleges keep out many worthy ones. Traditional entrance requirements call for scholarship and only rarely do they take into account qualities of leadership, personal traits, character, qualities of industry, honesty, and purposefulness. The question is raised as to whether so many educational institutions are really overcrowded nowadays. The American Council of Education in 1924 set a standard of 12 students per teacher and 16 hours of teaching per week. It will be hard to convince the public that this is overworking the teachers or crowding the class-rooms. Colleges are endowed for the benefit of American youth to be educated, not for the teachers on their payrolls. SY

Why Schooling Costs So Much. FREDERIC BURK. *Survey*, **54**, 557–61 (1925).—Data are given showing that elementary, secondary, and higher education costs are increasing at a rapid rate. As a nation we are wasteful with our resources in other respects, but the increased cost is not due to large, careless, visible waste. It is not due to an increased attendance in the elementary schools, but to high-school and college enrolment which has increased enormously in the last decade. The reason for the increase is the new course of study at high schools and colleges, which enables a man to become an efficient workman of the world, and a belief that through worldly experience we realize the highest ideals of the soul. The Great Unconscious of civilization is silently but irresistibly shaping education to its own ends. SY

Ox Cart or Auto—Which? E. V. HILL. *Am. Sch. Board J.*, **71**, 47–50 (Sept.), 49–50 (Oct.) (1925).—This is a continuation of a discussion of the essentials of air circulation in class-rooms. The requirement of 30 cu. ft. of air per pupil per minute must be considered mechanically and physiologically, and the quality of the air supplied is much more important than the quantity. Temperature, humidity, motion, and cleanliness of air are important. The author describes a "synthetic air chart" for use in adjusting ventilation. This chart, which was adopted by American Society of Heating and Ventilating Engineers in 1920, is based on all known factors (wet bulb differences, dust, bacteria, odors, CO_2) that determine air conditions in a room. Results of comparative studies on window and fan ventilation are given. SY

Toward Honors Courses. R. S. CRANE. *Bull. Am. Assoc. of Univ. Profs.*, **11**, 392–7 (1925).—One of the most significant movements in higher education in America gives evidence of continued vitality and growth by two recent events; the publication of a revised and enlarged edition of President Aydelotte's "Honors Courses in American Colleges and Universities" and the recent conference on honors courses at the State University of Iowa, March 17 and 18, 1925.

President Aydelotte's report shows that the number of institutions which have some form of honors courses has increased from an original number, in the first edition, of 44 to 93 in the revised copy. The large majority of the new courses are those for which honors are awarded for special work in addition to that for regular requirements. The other type of honors work, which either in part or entirely supersedes the usual system of courses for senior college students, has doubled in the number of colleges permitting it since 1924. The type of work which will relieve the gifted student, during the last two years, from formal and self-sufficing courses is coming. He is to be freed to work toward the mastery of an intelligently defined field of knowledge but to be faced in the end by a more severe test of his accomplishment than the usual course examinations afford.

The conference at Iowa City was "not to take any action but to talk together." It was called and sponsored by the National Research Council because the research workers come mainly from the gifted students and it is these students whose interests are at stake when honors courses are offered. The suggestion was made, however, that honors courses should not be thought of as research, for research should be reserved to label work only "which aims to add to the sum of human knowledge." The conference had two general themes before it; the need of honors courses and types of honors courses. The only formulation coming from it was in the form of eleven questions which sought to restate the main issues raised in the discussion. B. C. H.

The Premedical Course. ANON. *Bull. Am. Assoc. of Univ. Profs.*, **11**, 354–64 (1925).—The article gives a short history of the relations of the A. A. U. P. Committee D (on Relation of Vocational Guidance to General Higher Education) to the work of the Committee on Pedagogics of the Association of Medical Schools. The report of the last-named committee was adopted by the Association of Medical Schools on March 7, 1925.

The essence of the report, now in force in all institutions holding membership in the Association of American Medical Colleges, is somewhat as follows:

Admission to these schools may be by:

1. Satisfactory completion of a minimum of collegiate instruction.
2. Examination.

The minimum of collegiate instruction is sixty semester hours of work including:

1.	General Chemistry	8 hours including 4 hours laboratory
	Organic Chemistry	4 hours
2.	Physics	8 hours including 2 hours laboratory
3.	Biology	8 hours including 4 hours laboratory
4.	English Literature and Composition	6 hours

Work in qualitative analysis may be included in the course in general chemistry. The organic chemistry is said to consist of didactic exercises covering a discussion of the aliphatic, carbocyclic, and heterocyclic series. It is urged that the physics course be preceded by a course in plane trigonometry.

In case the candidate is admitted by examination, he must have in every case completed not less than sixty hours of collegiate work and "give evidence of scholarship of high order." The general attitude of the medical school authorities upon the premedical work may be well summarized in the following: "The student must be left

in a position to extend his knowledge with reasonable confidence and success by his own efforts as his future interests develop." B. CLIFFORD HENDRICKS

The Mental Attainments of College Students in Relation to Previous Training. J. W. GOWEN AND M. GOOCH. *J. Educ. Psychol.*, **16**, 547–68 (1925).—A study of the relationship of mental attainments in such high-school subjects that are continued in the college freshman year as algebra, English, chemistry, geometry, Latin, and French, was made of 927 B.S. graduates (1909–17) of the University of Maine. This study of high-school ability in comparison with college attainment shows that marks obtained by college students are in a measure dependent on ranks obtained by students in high school. The average weighted correlation coefficient between any one high-school subject and all the corresponding freshmen subjects, varies from +0.247 for chemistry to +0.336 for French. Therefore it is concluded that high-school English is as good an indication of a student's subsequent ability in college chemistry as is chemistry itself. Also, that all of the generally accepted high-school subjects have approximately equal training value.

The studying of chemistry in high school being a disadvantage to the student when he came to college and studied chemistry, can easily be explained by the fact that our educational system favors the more able student taking Latin or French in the high school and then again favors the slightly inferior student taking chemistry. The better student seems to avoid high-school chemistry. W. G. K.

Advantages of Teaching. ANON. *Penna. Sch. J.*, **74**, 31 (1925).—Penna. State Kappa Delta Pi presents the advantages of teaching to high-school students by means of a letter sent to principals. A brief summary of the letter is: 1. Salary; ranging from $1000–$5000. 2. Other Compensations; such as shaping the ideals and molding the thought of the plastic oncoming generations; 3. Conditions of Service; teaching is a natural, easy transition from the life of the student. Note its numerous and extended vacations; its comparatively short working days; good working conditions and environment; a usual long tenure. 4. Enlarged Opportunities; there are more teachers being required every day in the numerous fields of education; special teachers; special classes; investigation and research opportunities. J. HOWARD GRAHAM

Uniform Marking System. RUSSELL C. ERB. *Penna. Sch. J.*, **74**, 169.—Erb says that Total Range is most important in this system of marking. If the Total Range amounts to less than 60% of the highest mark that is possible to be made, then instead of dividing total range by 4 quarters, it is divided into 3 thirds. In other words no D's are given under such conditions.

Example:	Highest mark possible	92
	Highest mark made	52
	Lowest mark made	0
	Total range	52

The total range of 52 is divided into 3 thirds and only the letters A, B, and C are given.

Example with monthly test marks:

	Highest mark in test	27
	Lowest mark in test	3
	Total range	24

The total range of 24 is more than 60% of the highest mark possible, therefore 6 will now be the range for each quarter and grades will be assigned as follows:

27–21	"A" quarter of the class
20–15	"B" quarter of the class
14– 9	"C" quarter of the class
8– 3	"D" quarter of the class

Monthly recitation grades can be calculated and assigned in a similar fashion.

J. HOWARD GRAHAM

The New Curriculum. EDITORIAL. *J. Natl. Educ. Assoc.*, **14**, 269–70 (1925).—Comments upon the National Education Association commission's report upon the revision of secondary education in which it was stated that every one should learn (1) how to keep well, (2) how to use fundamental processes, (3) how to make a good home and rear children, (4) how to work efficiently and happily, (5) how to be a faithful citizen, (6) how to spend leisure wisely, and (7) how to regulate one's life according to the standards of right living. T. G. T.

Tenure for Teachers. FRED M. HUNTER. *J. Natl. Educ. Assoc.*, **14**, 271–3 (1925).—The teacher should have the right of security to his position if he works faithfully for the interests of his students. He should be free of fear of dismissal because of political influences and other causes which have no connection with his professional efficiency. T. G. T.

Why Homogeneous Group? JOHN H. BUTLER. *J. Natl. Educ. Assoc.*, **14**, 273–4 (1925).—Correlation between class work and intelligence as measured by tests, varies considerably. The dull pupil is publicly branded and this demoralizes his self-respect and courage. The border between bright, average, and dull groups has no sharp lines of demarkation. Shifting a student from one group to another theoretically is excellent but practically ineffective as these are not adequate standards.

Homogeneous grouping is a fallacy because it does not take into consideration individual differences. The student should be considered the unit and progress in each subject at his own speed. T. G. T.

$50,000 for Professors. FRANK BOHN. *J. Natl. Educ. Assoc.*, **14**, 281–2 (1925).—Abridgment of article appearing in *The Forum*, **74**, 491–501 (1925). T. G. T.

Adventures in Health Education. C. E. TURNER. *J. Natl. Educ. Assoc.*, **14**, 285 (1925). T. G. T.

Ammonia Production and Conversion Costs. F. A. ERNST. *Am. Inst. Chem. Eng.*, preprint, Dec., **1925.**—The cost of building and equipping a plant to produce 40 tons of synthetic $(NH_4)_2SO_4$ per day by the process developed at the Fixed Nitrogen Research Laboratory at Washington is about $873,790. An additional fund amounting to $226,210 would be required for operating expenses. In the process elaborated the hydrogen is prepared by the "electrolysis of water." The oxygen is removed from air by burning a part of the hydrogen. A preliminary NH_3 converter working at a high temperature removes most of the remaining impurities and the others are eliminated when the small amount of NH_3 formed is condensed. The NH_3 gas is passed through dilute H_2SO_4 in a saturator operated at 215°F. The crystal-laden acid is run to settling basins and the $(NH_4)_2SO_4$ separates. The crystals are centrifuged and the mother liquor is returned to the system.

It is believed that such a plant will produce $(NH_4)_2SO_4$ at a cost of $50.02 per ton for 5 years and return the entire sum of $1,100,000 to the investors during this period. The sixth year and thereafter, the cost would be $34.31. Ammonium sulfate sells for approximately $59 a ton. Assuming a selling cost of $2.95 a ton, the return for the first year would be 7.67%. This would increase until a return of 27.67% would be reached the sixth year. If the plant is paid for in ten years, the cost would be $42.16 per ton the first year, corresponding to a return of 17.67% and decrease to $34.31 for the eleventh year, which corresponds to a 27.67% return. G. B. HEISIG

Water Supply as a Factor in Locating Chemical Plants. W. D. COLLINS. *Am. Inst. Chem. Eng.*, preprint, Dec., **1925.**—The quantity and quality of the water supply are important factors to be considered when locating chemical industrial plants. Many public water supplies are not operating at maximum capacity either on account of a limited supply of water or limited equipment. Private surface water supplies can be relied on only if observations of stream flow, etc., covering a period of 30 years are available. Private ground water supplies have the advantage of little seasonal variation but the quantity is limited by the amount of water in the ground and the ease with which the water reaches the well. There is a general tendency for the artesian water supply to decrease even though the wells are properly drilled, capped, etc., on account of the general lowering of water in the ground. The water level has fallen 50 ft. in the last 20 years in some places. State regulation governing the drilling and use of artesian well water is practiced in North Dakota in order to conserve the supply.

The quality of the water is less limiting than the quantity available in most cases. There should be sufficient unpolluted water to meet the needs, for it is not safe to have both polluted and unpolluted water available on account of the danger of the workers drinking the polluted water. The color and turbidity of a water may be removed by proper treatment, and the odor is ordinarily of little importance. However, it is quite important to have data concerning the temperature of the water during the entire year. The temperature of water at the waterworks intake at the waterworks system at Cincinnati varied from 40°F. during the winter to 81–82°F. during July and August. During the later months it would be impossible to use the water in condensers in many operations. The hardness of water may be a deciding factor, but more frequently is a condition which must be accepted and the water treated. Analyses covering a year or more are necessary for fairly accurate knowledge of the chemical properties of surface water. G. B. HEISIG

Local Activities and Opportunities

University of Nebraska. The interested faculty members of the Arts and Science College are holding monthly after-dinner discussions centering around the aims, the curriculum and administration of the liberal arts college. These conferences are entirely informal and are under the leadership of Dean Herman James.

Miss Dora Burnell who did graduate work for her master's degree at the University of Nebraska last year has accepted a position as half-time instructor for the remainder of the current school year in the department of chemistry.

University of Florida. Organization of á Sigma Xi Club has just been completed at Florida. The club is composed of those members of the faculty who belong to various chapters of Sigma Xi throughout the country. It will have regular meetings throughout the year, at which time papers will be presented embodying the research problems being carried out by its members. Dr. T. R. Leigh, head of the department of chemistry, is Vice-president of the club and Professors Fred H. Heath and V. A. Jackson, of the chemistry staff, are members.

Desiring to familiarize college students of Florida with the life and work of Dr. John Gorrie, inventor of the first successful process for making artificial ice, and one of Florida's representatives in the national hall of fame, the Florida Division, United Daughters of the Confederacy is offering a medal for the best essay written on the subject, "Gorrie's Economic and Humanitarian Gift in Its Relation to the Development of the Resources of the South, America, the World." Mrs. Townes R. Leigh, wife of the head of the department of chemistry, is State Historian and Chairman of the Committee on awarding the medal.

Mr. Z. A. Pirenian, student of chemical engineering, U. of Florida, was elected Grand Treasurer of Gamma Sigma Epsilon Chemical Fraternity at its recent national meeting.

Dr. E. D. Ball, Entomologist to the Florida Plant Board and formerly Entomologist of the State of Wisconsin, addressed the January meeting of the Sigma Xi club. His subject was "Relationship of Salary to Training and Experience in the Scientific Field."

Plans for the first unit of a new chemistry-pharmacy building are practically complete. The first unit will cost approximately $220,000. In planning the building, particular attention has been devoted to embodying many of the recent advances in the construction of buildings of this type.

Dr. T. R. Leigh, head of the department of chemistry, is acting as state chairman of the Garvan prize essay contest.

New England Association of Chemistry Teachers. Ninety-eighth meeting at the High School, Everett, Massachusetts, Saturday, February 13, 1926.

Program

9.00—Meeting of the Executive Committee.

9.30—"A Visit to the Borax Plant of the American Trona Co. at Searles Lake, California" by Mr. Wilhelm Segerblom, head of department of chemistry at Phillips Exeter Academy.

10.00—"Carbon Monoxide as a Health Hazard," Professor H. Monmouth Smith of the department of chemistry, Massachusetts Institute of Technology.

10.30—"Research Work at the Watertown Arsenal," Colonel L. T. Dickson, Ordnance Department, U. S. A.

11.00—"Some Experiments with Dyes," Mr. Charles H. Stone, head of the department of chemistry, English High School, Boston.

11.30—"The Progress of Refrigeration," Mr. Everett R. Ryan, Sales Manager of the Tenney System.

12.00—Business Meeting.
Election of New Members.
Reports of Committees.
New Business.

12.30 P.M.—Lunch in the High-School Lunchroom.

1.30—"The Story of Gasoline," 3-reel motion picture, shown by courtesy of the Bureau of Mines.

Miss Laura P. Patten, head of the science department of the Medford, Massachusetts, High School, has arranged a series of lectures to be given at the Massachusetts Institute of Technology by experts in their respective fields of modern chemical developments under the direction of the N. E. A. C. T.

This series of lectures shows the modern material that is being emphasized by this Association. It is expected that there will be a large attendance at all these lectures. The School authorities of Boston and Somerville, as well as other cities, have accepted this course for promotional credit to the extent of 15 hours.

The list of lectures and lecturers follows:

Jan. 6 "Atomic Structure," Prof. W. C. Schumb
20 "X-rays in Chemistry," Prof. G. L. Clark
Feb. 3 "Recent Developments in Radiation Chemistry," Prof. R. H. Gerke
17 "Valence," Professor Edward Mueller
Mar. 3 "Colloid Chemistry" (historical), Professor D. A. MacInnes
17 "Colloid Chemistry" (theoretical), Professor D. A. MacInnes
31 "Industrial Advances in Organic Chemistry," Prof. J. W. Phelan
Apr. 14 "New Uses of Carbon and Petroleum as Raw Material in the Chemical Industry," Prof. J. W. Norris, Pres. A. C. S.

Details of these lectures may be obtained by writing Miss Patten.

Chicago C. T. A. At the December meeting of the Chicago Chemistry Teachers' Association, Herbert R. Smith presented a plan of laboratory training suitable for the capabilities of each member of the class. By actual test more than half of the pupils doing laboratory work were found not to be obtaining values commensurate with the time spent, chiefly because they could not or would not properly direct their energies.

The plan proposes a division of the class on the basis of ability to learn. Those that are proficient work more under their own direction with occasional consultation with the instructor. The others are kept under close supervision and specially trained in the art of experimenting until they are able to get results under their own management. This plan brings the class to a satisfactory standard by the close of the first half-year. Some who do not make enough consistent effort are required to repeat the work before going on with the second half-year.

A full report of the plan will appear soon in the JOURNAL OF CHEMICAL EDUCATION. At this meeting Mr. Ben H. Ball of Deerfield Shields High School was elected Contributing Editor of the JOURNAL OF CHEMICAL EDUCATION to succeed Herbert R. Smith, of Lake View High School, Chicago.

University of Minnesota. The School of Chemistry is presenting this year a series of public lectures by well-known chemists. The first lecture was given Nov. 24th by Dr. F. G. Cottrell of the Fixed Nitrogen Laboratory at Washington, on "The Outlook for Nitrogen Fixation." His lecture was illustrated by lantern slides. The second of the series was given on Dec. 1st by Dr. J. Kendall of Columbia University. Dr. Kendall spoke on "The Rare Earths."

The third lecture was given on Jan. 12th by Dr. W. D. Harkins of the University of Chicago, who spoke on "Atom Building and the Photography

of Atomic Disintegration." Dr. W. A. Noyes spoke Jan. 27th. Arrangements have been made for Dr. W. K. Lewis of the Massachusetts Institute of Technology to lecture on Feb. 16th. Other speakers are being secured for lectures in the spring.

The faculty and students of the University have also been fortunate in being able to hear other noted scientists. Dr. R. Millikan of the California Institute of Technology spoke on "Theories Underlying Colloid Phenomena." Dr. C. G. Derrick spoke on the "Development and Present Status of the Coal Tar Dye Situation." Dr. Martin Fischer, on "Colloid Chemistry in Biology and Medicine," and Dr. J. A. Wilson, on the "Chemistry of Leather."

There were 2181 students registered in undergraduate courses given in the School of Chemistry during the fall quarter. The students were divided among the various departments as follows:

Inorganic and qualitative	1452
Analytical	131
Organic	263
Physical	159
Technological	49
Chemical Engineering	127

There were 180 undergraduate students registered in the School of Chemistry, of whom 74 were freshmen. In addition, there were 42 graduate students who are candidates for higher degrees.

A division of Chemical Education is being organized in the local section of American Chemical Society. An associate membership has been created to enable teachers of chemistry who are not members of the American Chemical Society to participate in the meetings. A subscriber to the JOURNAL OF CHEMICAL EDUCATION automatically becomes an associate member of the local section.

Eastern N. Y. Section, A. C. S. The annual meeting of the Eastern New York Section of the American Chemical Society was held in the Chemistry Building of Union College, Schenectady, Friday evening, December 18, 1925.

Officers elected for the coming year were: Dr. Wheeler P. Davey, General Electric Co., *Chairman;* Dr. Thomas A. Wilson, Union College, Secretary; Dean Edward Ellery, Union College, Schenectady, Dr. M. A. Hunter, Rensselaer Polytechnic Institute, Counsellors; Executive Commitee: Dr. A. Knudson, Albany Medical College; Dr. C. B. Hurd, Union College, Schenectady; Dr. T. F. McClester, Ludlum Steel, Watervliet; Dr. M. A. Hunter, Rensselaer Polytechnic Institute; Dean Edward Ellery, Union College, Schenectady.

Eleven meetings were held during the year which were addressed by Dr. Edwin E. Slosson on the "Human Side of Creative Chemistry;" Dr. Martin Fischer, University of Cincinnati, "Lyophilic Colloids;" Dr. Zay Jeffries, "Aluminum;" Dr. David Marine, "Iodine and Goitre;" Dr. Herbert Freundlich, "Aggregation and Form of Colloidal Particles;" Dr. L. E. Wise, Syracuse University, "Chemistry of Cellulose."

The committee for Chemical Education and Coöperation with the High School, consisting of Dean Edward Ellery of Union College, Dr. M. A. Hunter, Rensselaer Polytechnic Institute, B. S. Bronson, New York State College for Teachers, Albany, has reported that unusual success has attended the visits of various members of the section to the high schools near by. The plan of cooperation includes lectures and conferences in the high schools where desired, and the establishment of a clearing house of information, to which high-school teachers or others may present their problems. These activities are to be continued during the present year.

A conference and round table discussion of the Chemistry Teachers of the Eastern New York District will be held in the Chemistry Room of the New York State College for Teachers, Saturday, March 20th. The subjects for discussion will include those brought to the conference by the high-school teachers with special em-

phasis on Objectives in Chemistry and Modern Methods. This is the second annual conference of this group.

Princeton. The department of chemistry has 13 part-time Assistantships which pay $650 per annum, together with free tuition in the Graduate School, as well as free laboratory supplies. The assistants devote about 8 hours weekly to laboratory and class-room teaching. Applicants for these positions should address at once the Chairman of the Department of Chemistry, Princeton, N. J.

Professor Lauder W. Jones has been granted leave of absence for the second term. He will spend eight months visiting universities in various parts of Europe, in order to gain information concerning the present activities in chemistry in the laboratories and institutions.

Dr. Jones attended the first meeting of the National Symposium of Organic Chemistry, which was held at Rochester, N. Y., December 29th, 30th and 31st, and presented a paper on "New Aspects of the Beckmann Rearrangement."

Professor Donald P. Smith has been granted leave of absence for the second term, and will sail in February for Europe. Dr. Smith will spend part of the time, in study, at Munich.

Dr. N. Howell Furman, Asst. Professor of Chemistry, has accepted an invitation to become associated with the staff of the chemistry department, Stanford University, California, for the Summer Quarter, 1926. He will probably offer a special course dealing with selected topics bearing on the chemistry of dilute solutions, with special emphasis on electro-chemical principles and their applications.

Professor William Foster has been chosen by the New Jersey Science Teachers' Association as a member of the Senate of Chemical Education of the American Chemical Society.

The annual smoker and entertainment of the Princeton Chemical Club was held Friday evening, January 15th. Dr. Wm. J. Hale of the National Research Council gave a talk on certain phases of his work in Washington.

The College Entrance Examinations Board has appointed Professor Charles L. Fleece, of Princeton University, Chairman of the Committee which has charge of the preparation of examinations in chemistry for entrance to college. Professor Fleece has been a member of this Committee for some time.

Alabama Section of the A. C. S. A Division of Chemical Education of the Alabama Section of the American Chemical Society has been organized. The following officers have been elected:

Chairman, Dr. S. J. Lloyd, University of Alabama.

Vice Chairman, Mr. Mann, Woodlawn High School, Birmingham, Ala.

Secy. and Treas., Alden K. Boor, Birmingham Southern College.

At a meeting of the officers at Birmingham, January 14th, plans were formulated for a meeting. This is to be held in Birmingham during the convention of the Alabama Educational Association, March 25th, 26th and 27th. Speakers for this meeting are to be announced later. Personal letters are to be sent to teachers of high-school chemistry in the state inviting them to the meeting.

Ohio. The chemistry teachers of Northeastern Ohio have launched a new chemistry teachers' association. The idea was unanimously favored by those present at the N. E. O. T. A. meeting in Akron on December 12th, at which time the following officers were elected: *President*, V. S. Culp, West High School, Akron; *Vice President*, C. W. Fretz, McKinley High School, Canton; *Secretary-Treasurer*, M. V. McGill, Lorain; *Executive Committee*, E. G. Pierce, East Tech., Cleveland, and C. H. Salter, Lakewood.

The Executive Committee met in Cleveland on January 9th and drew up a constitution modeled after that of the New England Association.

We understand that the new organization has already laid definite plans for

work covering a period of years and that some of this work is already well under way.

Lafayette College. The Research Committee of Lafayette College, Easton, Pa., for the eighth year announces two Fellowships in Physical Chemistry, amounting to seven hundred and fifty and five hundred dollars ($750 and $500), respectively, to be awarded to graduates of American or Canadian colleges with a training equivalent to that required for the degree of Bachelor of Science in Chemistry at Lafayette College. The holders of the fellowships are not expected to pay tuition and they are not permitted to engage upon other gainful occupations during the academic year. They are not to be called upon for teaching duties. The work done may be counted toward an advanced degree and it is hoped that the results of the research will have sufficient value to merit publication. The greater portion of the time of each Fellow will be devoted to the prosecution of a research problem, which will probably be connected with the nature of the viscous or plastic flow of matter.

The researches are generally theoretical in character, being related to the fundamental properties of fluidity, plasticity, and elasticity, but they have sometimes been of a more practical character, in the attempt to correlate the property of plasticity with those somewhat vaguely used terms in various industries, such as consistency, workability, hardness, shortness, et cetera.

Applications should be addressed to the Chairman of the Research Committee, before March first, giving a statement in regard to the training, character, and experience which will enable the Committee to judge the merits of the candidates. No special form of application is required but the applicant should submit a photograph and letters of recommendation and references.

Yale. The department of chemistry of Yale University has available each year a limited number of laboratory assistantships, scholarships, and fellowships, which afford financial aid to students who are candidates for a higher degree in chemistry or chemical engineering.

Laboratory assistants are called upon for periods of work aggregating not more than twelve hours a week in an undergraduate laboratory; such periods usually come before noon, and an effort is made so to arrange the hours as to minimize interference with graduate studies. The compensation is at the rate of $750 a year, out of which tuition, laboratory fees, and breakage amounting to about $250 a year have to be paid. To those whose work both as graduate student and laboratory assistant is satisfactory, the department will award assistantships a second year at an increase of $150.

Scholarships and Fellowships are usually not awarded to men applying from outside the department, but are reserved primarily for candidates for the Ph.D. degree who in the succeeding year will be fully occupied in completing their work and hence cannot then act as laboratory assistants. There is, however, the Loomis Fellowship of $1200, which is awarded on the basis of a competitive examination, held near the end of the academic year, open to all graduate students in chemistry who have been in residence during the year.

Application forms may be obtained on request addressed to the Chairman, Department of Chemistry, Yale University, New Haven, Connecticut; all required information should be in his hands not later than March 1st. Notice of award will be mailed April 1st.

Brown University. The John Howard Appleton Lectureship, which was established in 1923 by the friends and former students of Professor Appleton, in appreciation of his services of over fifty years as teacher and professor of chemistry at Brown University, has an unusually interesting program this year.

A series of four lectures have been planned, the first of which was given by Professor Alexander Findlay of the University of Aberdeen on October 7, 1925.

His subject was "The Colloidal State and Some of Its Properties."

The remaining lectures are as follows: On January 21st, Dr. Colin G. Fink, professor of chemical engineering at Columbia University, spoke on "Electrolytic Restoration of Ancient Bronzes."

Dr. Glenn E. Matthews, Photographic Chemist of the Eastman Kodak Company presented the third lecture on February 11th. His subject was "Color Photography."

On March 18th, Dr. Gustavus J. Esselen, Jr., of the firm of Skinner, Sherman, and Esselen of Boston, will present for his subject, "A Brief Consideration of Cellulose with Particular Reference to the Manufacturing and Use of Rayon."

Professor Herbert F. Davison of Brown University has been re-elected Vice President of the New England Association of Chemistry Teachers for the coming year.

The Graduate School of Chemistry of Brown University awarded six doctorates last June. Of these, five have entered the teaching profession. They are now located in the following places:

Dr. Wayland M. Burgess is now assistant professor of chemistry at the University of Cincinnati.

Dr. Ralph H. Bullard, formerly of Hobart College, Geneva, New York, has returned there as professor of chemistry.

Dr. Ralph P. Seward has accepted a position as professor of physics and mathematics at Catawba College, Salisbury, N. C.

Dr. Philip C. Scherer, Jr., is connected with the chemistry department at Dennison University, Granville, Ohio.

Dr. Warren C. Johnson is instructor of graduate research at Brown University.

Dr. Ernest W. Johnson is with the Anglo-Chilean Cons. Nitrate Corporation at Tocopilla, Chile, as research chemist.

Facts are the body of science, and the idea of those facts is it spirit.—S. BROWN

Solving the Riddle of Insulin. Insulin, the extract from the pancreatic gland, that was first prepared by Banting and Best at the University of Toronto three years ago and since used extensively in the treatment of diabetes, may soon be made by synthesis in the chemical laboratory, according to a statement by Professor Treat B. Johnson of Yale University at the American Chemical Society meeting in Rochester.

Professor John J. Abel of Johns Hopkins University, who has been studying the structure of the natural insulin, has come to the conclusion that it is an "auto-oxidizable sulfur compound, probably of the thio-peptide type." This means that it is an unstable substance similar to ordinary albumin in composition but simpler in structure. Professor Johnson announced that research has been started in the Yale laboratories on the structure and reactions of this kind of compound in the hope that it may lead to a method of making it artificially, or to the discovery of a substitute of value in medical science.

Insulin belongs to the class of secretion of the ductless glands, known as "hormones," which in minute amount circulate through the blood and control bodily processes. Insulin is the hormone that regulates the utilization of sugar from which the muscles obtain their energy. In diabetics it is lacking but may be supplied by injections of the prepared insulin.—*Science Service*

Recent Books

Fundamentals of Physical Chemistry. DR. ARNOLD EUCKEN, Professor of Physical Chemistry in the Technischen Hochschule, Breslau, Germany. Translated and adapted from the second German edition by ERIC R. JETTE, Ph.D., Instructor in Chemistry, Columbia University and VICTOR K. LAMER, Ph.D., Assistant Professor of Chemistry, Columbia University. McGraw-Hill Book Company, Inc., New York, 1925. xiii + 699 pp. 20 × 13.5 cm. $5.50 net.

The contents comprise the translators' preface of about two pages and the author's preface to both the first and second German editions covering about four pages, table of contents of three pages, somewhat more than four pages devoted to listing all of the symbols used in the text, a Mathematical-Physical Introduction of 34 pages, 637 pages of text and finally an author and subject index of 27 pages. In addition to tabulated data the text carries 99 illustrations. The book conforms in size and general appearance to the other books of the International Chemical Series, so familiar to chemists.

The translation is very well done with very few errors noted by the reviewer, and in giving this translation a very valuable service has been performed for American chemists. The reviewer knows of no book of this size which presents the subject of theoretical chemistry in such detail and for the most part so modern in its treatment. The author has avoided much repetition in the text by referring to equations by number.

The features of the book which appear unique to the reviewer are the portions of the book dealing with solutions and the structure of matter. The translators have rewritten the portion on solutions for this translation introducing a brief discussion of the modern theories of Milner, Debye, and Hückel, and have added many footnotes throughout the text. This has increased the value of the book to American chemists.

The portion of the book on the structure of matter appears to be the most interesting part. It is a clear, logical presentation of the subject that is very timely and which by itself should commend the book to American teachers and investigators.

J. C. W. FRAZER

Colloid Symposium Monograph. Papers presented at the Third National Symposium on Colloid Chemistry at the University of Minnesota, June, 1925. Edited by HARRY N. HOLMES, *Chairman*, Committee on the Chemistry of Colloids, National Research Council, assisted by HARRY B. WEISER, Chairman-Elect. The Chemical Catalog Company, Inc., New York, 1925. vi + 323 pp. 16 × 23 cm. $5.00 postpaid.

This volume contains twenty-two entirely independent papers which were presented at the Third National Symposium on Colloid Chemistry held June 17 to 19, 1925, at the University of Minnesota.

In the Foreword the editor says, "With this Monograph the Colloid Committee of the National Research Council firmly establishes a series of important annual publications. In Volume I were collected the papers presented at the First Colloid Symposium (University of Wisconsin); in Volume II the papers read at the Second Colloid Symposium (Northwestern University) were published; and in Volume III we now offer the papers read at the Third Colloid Symposium (University of Minnesota). As usual, theory and application are both given adequate attention. Medicine and agriculture are prominent, but so are orientation of molecules, surface tension, and electrokinetic potential. Professor Herbert Freundlich, as the foreign guest of honor at the Symposium, made a notable contribution to the discussions. His paper is a valued part of this volume."

The papers presented are listed below:

1. "On the Electrokinetic Potential," by Herbert Freundlich.
2. "Molecular Weight and Solution," by Wilder D. Bancroft.
3. "Some New Aspects of the Surface Tension of Colloidal Solutions Which Have Led to the Determination of Molecular Dimensions," by P. Lecomte du Noüy, Sc.D.
4. "The Distribution and Orientation of Molecules," by Irving Langmuir.
5. "Photographic Sensitivity: A Colloid Chemical Problem," by S. E. Sheppard.
6. "Catalysis by Metalized Silica Gel," by L. H. Reyerson and Kirk Thomas.
7. "Colloidal Water and Ice," by Howard T. Barnes, D.Sc., F.R.S.
8. "The Colloid Chemistry of Rennet Coagulation," by L. S. Palmer and G. A. Richardson.
9. "The Colloid Chemistry of Protoplasm," by L. V. Heilbrunn.
10. "The Effect of Surface Tension Depressants upon Bacterial Toxins," by W. P. Larson, H. O. Halvorson, R. D. Evans, and R. G. Green.
11. "Physico-Chemical Studies of the Mechanism of Blood Clotting," by I. Newton Kugelmass.

12. "The Effect of Anions upon the Physical, Colloidal, and Chemical Properties of Aluminium Hydroxide," by Lewis B. Miller.

13. "Nature of the Colloidal Soil Material," by P. L. Gile.

14. "The Colloid Chemistry of Soils," by Emil Truog.

15. "The Power of Soils to Absorb Water from Air," by F. J. Alway.

16. "Mechanism of Lithopone Formation," by Charles A. Mann.

17. "An Experimental Study of Emulsification on the Basis of Distribution of Size of Particles," by Alfred J. Stamm.

18. "The Centrifugal Method for the Determination of the Distribution of Size of Particle of Suspended Material," by J. B. Nichols and Henriette C. Liebe.

19. "Elasticity and Some Structural Features of Soap Solutions," by William Seifriz.

20. "A Simplified Slit Ultramicroscope," by L. V. Foster.

21. "The Plasticity of Rubber and Its Sols—1," by W. J. Kelley.

22. "A Motion Picture Study of the Influence of Gelatin on Rates of Crystal Growth and Solution of Copper Sulfate," by W. G. France.

This volume serves admirably to bring together some of the outstanding views of a few of the leaders in this field of physical science. And since this field is developing, both theoretically and industrially, with such great strides it appears to be very much worthwhile that men engaged in studies on the various ramifications of colloidal behavior should get together from time to time to participate in an exchange of views. At the symposiums, one is rewarded by hearing a real exchange of opinion in the form of discussions of the papers. The reviewer notes with extreme regret that in the volumes which present the papers of the second and third symposiums, the discussion is omitted entirely. He feels that a large part of the benefit derived from attendance at the symposiums is lost in the publication of the papers by the omission of this discussion.

Some of the papers cover a specific series of experiments which bear on some aspects of colloidal behavior. Others present rather the formulation or development of theory or law which has resulted from the correlation and building together of many extensive series of experiments. These latter seem to be much the more important type of paper for a gathering of this nature. Among such important contributions in the present volume, the papers of Freundlich, Lecomte de Noüy, Langmuir, and Sheppard may be mentioned as of particular value.

R. H. BOGUE

Principles of Education. J. CROSBY CHAPMAN AND GEORGE S. COUNTS. Houghton Mifflin Co., Chicago, 1924. viii + 645 pp. 12.5 × 18.8 cm. $2.75.

The reviewer will not attempt to evaluate this volume in terms of its psychology nor the soundness of its philosophy, but rather in terms of its helpfulness to the teacher of chemistry in our colleges and high schools.

Any thoughtful teacher is soon brought face to face with the importance of aims of his course. To properly evaluate such aims they must be projected against the general aims of education as a background. The volume under review holds that there are six major social aims for education: the furtherance of health, the promotion of family life, the ordering and humanizing of economic life, the advancement of civic life, the enrichment of recreational life and the fostering of religious life. Whether or not we, as teachers of chemistry, accept these as a whole or in part, we shall find the effort to relate our course's aims to them a profitable exercise.

To what degree should the types of student taught modify both content and method of a given course? "This," you say, "is a question of the psychology of both the student and of the subject-matter." In this, "The Principles of Education," considers education conditioned by: original nature, habit formation, language, reflection, and individual differences. Would Chemical Education not be equally influenced by such factors?

"How?" is the interrogation of the one who is seeking method. How shall we be educated? What part shall the elementary school, the high school, the college take in this process? What method shall control instruction? Even, who shall do the teaching? These are all considered in the fourth part of the book.

Those of us who had our psychology a generation ago will find this a helpful modernizer of our thinking in that field. And whether we welcome it or not the social interpretation of the aims and content of school subjects is with us today in a form that cannot be ignored. From these two viewpoints alone the book under review merits a careful reading at the hands of chemistry teachers.

B. CLIFFORD HENDRICKS

An Introduction to the Literature of Chemistry. F. A. MASON. Oxford University Press, New York, 1925. 41 pp. 12.5 × 18.5 cm. $.70.

The title of this excellent little book is indicative of its purpose. Heretofore it has been a necessary task of the teacher of advanced students to acquaint them with the literature of chemistry and the best way of using it. Such instruction was apt to be quite insufficient to accomplish its purpose. Hence all teachers will welcome Dr. Mason's filling of this long felt need.

The book is divided into two parts, (1) the literature itself, (2) the manner of making a search. Part (1) is discussed under the following heads: General Dictionaries and Encyclopedias, Journals and Periodicals, Abstract Journals, Text-Books and Special Works of Reference (this

being suitably subdivided), Special Literature of Dye Chemistry.

Dr. Mason does not claim to list more than a fraction of the reference works of merit. Nevertheless the critic was surprised to note the omission of such standard works as Taylor's two volume "Treatise on Physical Chemistry," Lewis and Randall's "Thermodynamics," Mulliken's "Identification of Pure Organic Compounds," Scudder's "Conductivity and Ionization Constants of Organic Compounds" and Lewkowitsch's "Technology of Oils, Fats and Waxes." On page 22 Guertler's (rather than Guerta's) "Metallographie" is undoubtedly intended.

However, the critic wishes to repeat that every advanced student and teacher can profit by using this book. MALCOLM HARING

The Story of Early Chemistry. JOHN MAXSON STILLMAN. D. Appleton & Co., New York, 1924. xiii + 566 pp. 13.5 × 21 cm. $4.00.

This book will appeal to teachers and advanced students in chemistry. To the former it will give a vast fund of facts usable in the course of their class instruction, while to the latter it offers source material for their more exhaustive study. In short, it is supplementary in character and construction, as well as in contents, to most of the more recent volumes relating to the history of chemistry. The writer is quite sure that if read and discussed at length in chemical seminars it will be declared to be admirable.

But it lacks that personal touch which to the writer means so much in all chemical instruction. In a dignified composition, such as this publication, however, it might seem a bit strange, or out of place to bring in the personal element, which recalls that on one occasion when in conversation with "Billy" Mason (you all know that superb teacher up at Troy), the writer timidly ventured to narrate how he taught qualitative analysis—throwing in all sorts of illustrations to elucidate his various problems—when the dignified Sir William P. smilingly remarked, "But you wouldn't dare put all that into a book which you might write on the fascinating subject of Qualitative Analysis." The writer was humbled and subdued, yet he couldn't rid himself of the ever recurring thought, "Why not?"

We welcome this excellent book. We mourn the passing away of its distinguished author.

EDGAR F. SMITH

TO BE REVIEWED LATER

Fundamental Concepts of Physics—Heyl.
Scientific Method in Education—Trow.
College Chemistry—Newell.
Experiments in College Chemistry—Newell.
Laboratory Chemistry for Girls—Jaques.
Chemistry—Kessel.

Suggests New Theory of Evolution of Stars. Things are not always what they seem and stars with all the earmarks of old age may really be in their youth, astronomically speaking, according to the latest views of Dr. Henry Norris Russell, professor of astronomy at Princeton University. Dr. Russell's ideas on stellar evolution have been widely accepted among astronomers, but one difficulty that has puzzled them has been the fact that stars of nearly every possible type may occur in the same cluster. These different types are supposed to represent various stages in the normal evolutionary sequence, but it has also been thought that all the stars in the same cluster were formed at approximately the same time.

According to the latest improvements of his theory, however, Dr. Russell supposed that all the stars proceed through the same general course of evolution, but some are handicapped. The most massive ones start at the beginning, but those of less mass may start at the middle of the scale, without having passed through the earlier stages while those of least mass start near the end. As a result, if a large number of stars are formed at about the same time, the ones of small mass will be almost immediately in the same condition that their more massive brethren will only reach after many billions of years. The astronomer, examining their light with his spectroscope, will find them of different types and may think them to be of different ages.

The source of energy of the stars, at one time thought to be due to a gradual contraction of their bodies, may be supplemented by actual conversion of their matter into energy, as proposed by Prof. Eddington of Cambridge University, England, thinks Dr. Russell. He suggests that a star may at first contract, and then after it has reached a certain point, cease contracting and use up its actual substance by conversion to energy.
—*Science Service*

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Missouri	14	South Carolina	38
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